THE

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*WITH WHICH IS INCORPORATED*

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**THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.**

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## Editorial Opinion.

The compliment recently paid by one of our advertisements to an editorial from our columns offered pleasing evidence that these editorials are read; evidence which is not always forthcoming. In this connection we quote some remarks made at the recent Advertising Convention at Hastings by a representative of a well-known electrical engineering concern. He is reported as saying, in a talk on the "Services expected from a Trade Journal": "The value of the paper depends eventually on the appeal of the editorial, which should be bold, independent, and observant of every development." We are disposed to agree with this view, and with becoming modesty may indeed claim that this view has inspired our weekly efforts to bring to our readers a wider point of view. Obviously such expressions of opinion can only work by suggestion, and, taking the boldness and independence for granted, we have attached considerable importance to directing the attention of foundrymen to new developments, in whatever country they may originate. We believe that in the Press of daily events, important and unimportant, a useful service may be rendered by endeavouring to pick out for treatment those which appear to be of major importance, and to leave aside those of minor importance, however much space either may demand in the news columns. We believe that, when necessary, properly expressed editorial opinion, which endeavours to sum up the thoughts and ideas of the best minds in the industry, can be fruitfully inspirational and give guidance to readers. We should like foundrymen, hearing of some news, or reading of some event or development, to turn to the editorial columns with the unspoken question: "What does the 'F.T J.' say about it?"

Finally, we believe that the industry we serve has to have regard to many factors beyond matters of orders and contracts, methods of production and test, and to consider wider questions of world trade, economics, statistics and education of competing industries and rival materials and methods. We believe that sound editorial opinion can do much to create an informed opinion in the trade and give a proper perspective with regard to events which cannot fail in the long run, in whatever small degree, to have its influence even on the routine of daily business. Thus the trade will in an increasing degree become "foundry conscious," and have regard to the craft not merely as a means to an end but an important end in itself.

## British Traders and the Imperial Economic Conference.

The Association of British Chambers of Commerce, the Federation of British Industries and the Chamber of Shipping of the United Kingdom have now circulated a Report of the British Preparatory Committee for the forthcoming Imperial Conference. In addition to the main Report there are three appendices, representing the views of each Association. To say the least of it, the Report is exceedingly platitudinous, and non-committal. It savours of the usual council meeting, when something of a revolutionary question is to be studied, as it recommends the creation of machinery; that a permanent secretariat should be formed, and advises such bodies to take cognisance of the obvious—free from political bias. The Committee must have realised the abstract nature of their Report, as they conclude:—"The Committee regards the above points of principle as so greatly outweighing in importance any other aspects of the problem, that in the present Report it has been decided to limit its comments to these main matters of principle." We agree that such discreet observations do not and cannot jeopardise, or in the main influence, the work of the politicians, but surely advantage could have been taken of existing statistical knowledge to put forward—preceded by a diplomatic phase, such as "in the light of existing but admittedly incomplete and inadequate information"—a trading policy derived from consultation with their own members. This has already been done by some provincial chambers of commerce and the like. It would have given the politicians an invaluable lead in coming to a decision. At the moment all they can say to the Dominions and Colonies is that the British trading community desire us continuously to study the questions of Imperial economic unity and formulate an economic policy, but we have no idea as to whether they approve of free-trading conditions within the Empire or whether a system of inter-Imperial preferential tariffs would meet their requirements.

Industry has the habit of blaming the Government of the day for not stating the policies concisely and in plain language, yet, here is a case calling for the clearest expression of views, and all they have done is to call for a committee to study and report back. Naturally enough, and as has been statistically proved, no unanimity exists amongst British traders, but if the majority favour a policy, then surely we can assume that it would be likely to benefit in general the interests they represent. It is on these grounds that we deplore that "points of principle" is the keynote of the British traders' report to the Imperial Conference instead of a definite trading policy.



XUM

## Correspondence.

*[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]*

### Compressed Air in Steel-Foundry Practice.

*To the Editor of* THE FOUNDRY TRADE JOURNAL.

DEAR SIR,—On reading through the report of the discussion upon my Paper, "The Economic Utilisation of Compressed Air in Steel-Foundry Practice," read at Middlesbrough, I regret to find that I did not make it clear, either in my Paper or in the following discussion, that whilst the high-pressure compressors referred to are of the very latest design and construction, the low-pressure machines are, in every instance, of pre-war design and have had continuous hard service.

It is thus obvious that no true comparison can be properly made of the merits of these machines on their performance relative to the high-pressure machines, and such was not my intent.

The purpose of my Paper was to point out and emphasise the necessity of ascertaining the efficiency, from an economic viewpoint, of all compressors used in a foundry, especially so of the low-pressure machines, as often the word "low" as applied to pressure give a sense that here efficiency is relatively unimportant. Actually, in most foundries the efficiency of the low-pressure compressors is the more important, and yet it is common practice to install a second-hand machine of unknown pedigree when putting down a shot- or sand-blast equipment.

In many instances it would pay handsomely to scrap existing low-pressure compressors and acquire new ones, *guaranteed* by reputable makers, such as Alley & MacLellan, Bellis, Tilghman and others, whose names will readily occur to steel founders.

At some risk of reiteration:—Measure power input and air output continuously and thus ascertain true economic position.—Yours, etc.,

THOS. W. BARLEY.

Edgar Allen & Company, Limited,
Sheffield.

July 25, 1930.

## The Zinc Situation.

By "ONLOOKER."

At the moment the zinc market is awaiting the outcome of the producers' conference to be held at Ostend, and by the time these notes appear in print the results of their deliberations (if published) will be known. It will be remembered that the avowed intention of the Zinc Cartel was to peg the price of spelter at about £28, a level which appears ludicrous in the light of subsequent events, although it was not until the conclusion of last year that the quotation broke £20. Long before 1929 came to an end, however, the Cartel was, to all intents and purposes, defunct, for the output curtailment scheme had failed and the market was faced with the prospect of increasing stocks and a sagging quotation. A week or two ago the lowest point in the recent decline was touched, viz., £15 15s. per ton, and even at that level there did not appear to be any particular evidence of a change for the better.

Various factors have been at work in the zinc situation of late which have all conspired to depress values and keep the quotation at a level uneconomic as far as the mining interests are concerned. The galvanising industry has been at a low ebb, and high prices ruling for all kinds of brass, consequent upon the maintenance of copper at 18 cents for a prolonged period, have, to a great extent, reduced demand for the alloy, and this has, in its turn, naturally reacted upon the call for zinc. With copper down to 11 cents, brass makers are able to offer their product at a much more reasonable price, and the increase in use resulting from this ought to help spelter considerably. In the case of the galvanising trade, however, price does not enter into the question, for makers have reduced quotations in their endeavour to secure orders. The trouble here is that the upheavals in the Far East have all but closed a very important market, and exports of galvanised iron for the first six months of this year are down to a very marked degree.

At the present level of spelter prices there is not likely to be much opposition to the re-forming of the Zinc Cartel, for both European and American interests must be agreed that production at £16 is disastrous. To put the matter rather differently, all producers will agree that the intention to raise prices to a more economic level is entirely laudable, but some difficulty may occur in the *modus operandi* to be employed. One of the difficulties in controlling zinc production has always been the fact that this metal is made available as a by-product in obtaining others, but since straightforward operations in the releasing of zinc ore must now be carried on at a loss, it is fairly certain that a way out of the knotty problem of output curtailment will be achieved.

As the Tin and Copper Cartels have discovered only too plainly, not the least of the difficulties lying in wait for those who wish to cut down output is that arising from the variation of mining and production costs in different districts. Canada, for instance, which is one of the cheapest producers, contributed last year about eleven times as much zinc to the world's total as in the last year of the war, a record not equalled by any other country worthy of serious consideration in the spelter picture, for the 1918 total for Belgium was, of course, not normal. Output of spelter has now reached enormous proportions, the world total for 1929 being reported as 1,470,000 tons, an increase of some 50,000 tons on 1928 and just about twice the total of ten years ago. During that period there is no doubt that a tremendous incentive was given to the use of spelter, but it looks very much as if there is now very little room left for further expansion. Galvanising, of course, takes most of the zinc produced, and in normal times accounts for probably nearly one-half of what is used. Brass-making comes next and zinc sheets third.

At a low price world interest in spelter may revive, and it is therefore much to be hoped that if a Zinc Cartel be formed, values will not be unduly advanced. For the moment £18 appears to be a reasonable level, for, with worldwide trade depression obtaining, an unduly rapid upward movement would be fatal to eventual success.

## Catalogue Received.

**Welding Electrodes.**—We have received from Messrs. Alloy Welding Processes, Limited, of Ferry Hill Works, Forest Road, London, E.17, a copy of Bulletin No. 60, which is devoted to the consideration of electrodes for the welding of corrosion and heat-resisting steels and alloys.

THE DEATH HAS OCCURRED of Mr. Peter McLaren, a director of Messrs. Burgess & McLaren, Limited, brassfounders, of Coatbridge.

MESSRS. WALTER ROWLEY, LIMITED, builders' brassfounders, of Allesley Street, Birmingham, have taken over the business of Messrs. May & Podmore, Limited, aluminium and brassfounders, Wharfdale Road, Tyseley.

## Random Shots.

One of the common arguments used in the heavy industries about the high cost of production is the high cost of transport and heavy rail rates for goods. It is assumed almost universally to be one of the handicaps which the British manufacturer has to suffer. In an esteemed contemporary Mr. E. T. Good sets forth, so far without contradiction, that the British manufacturer has always enjoyed an advantage over his competitors in the matter of rail charges, and that this advantage is now greater than it was before the war.

* * *

Doubtless the fallacy arises from the figures for costs and receipts per ton-mile, which are bound to be high in a country where hauls are short. The cost of transport is roughly divisible into two parts, a cost depending on and proportional to the mileage covered, and a cost, by no means as small as might be supposed, to cover terminal charges, loading and unloading, and so on. In a small country the latter is bound to be large in proportion to the former. Thus in this country receipts per ton-mile are nearly 1½d., whereas in other countries it is less.

* * *

But if we take the cost of assembling raw materials for steel manufacture at a works in England and the cost of sending them to a port of shipment, the approximate cost in England is £1.08 for plants using foreign ore, and £1.05 for plants using home ores. The corresponding figures for our competitors in Belgium, Luxemburg or Lorraine and U.S.A. are roughly £1.3, £1.5 and £3.

* * *

Goods rates seem to have advanced more since the war in most European countries than in Great Britain, and the increases per ton-mile are, approximately: United Kingdom, one-fifth; Germany and Belgium, over one-third; United States, nearly one-half; and France's figure is more than doubled.

* * *

Some idea of the advantage gained by our compactness as a producing country is illustrated by the fact that for goods consumed or produced in the heavy industries (ore, fuel, iron, steel), the average British haul is 30 miles, Belgian 70 miles, French 200 miles, German 150 miles, American 500 miles.

* * *

In view of our comments from time to time on the development of the heavy oil engine in place of the petrol engine, a change which would alter the whole face of the motor industry, it is interesting to see the prediction at the Society of Chemical Industry conference recently that within five years heavy oil engines will preponderate on our roads. Is the trade thinking five years ahead?

* * *

There was an exquisite moment at a recent conference in London. A telephone man had dilated on how the telephone business had anticipated all the modern business tendencies of extinguishing competition, of rationalising, of saving labour by automatic installations, and so forth, when an American visitor got up and asked, if that was so why it had taken him three-quarters of an hour to get a simple local call from London. In the language of the parliamentary reporters, "No answer was given."

* * *

MARKSMAN'S BULLS-EYES.

The essence of modern progress is petrol.

Absinthe makes the heart grow fonder.

At a West End wedding they sang "Oh, for the wings of a dove," but the bride and groom went off in a Puss Moth.

Women are never as black as they are rouged.

MARKSMAN.

# Motive Power for Moulding Machines.*

By A. S. Beech (President, Foundry Trades Equipment and Supplies Association).

Just recently the writer has heard of renewed attempts to re-kindle a very old argument, and it perhaps will be useful to go over the ground once more and to study the merits and demerits of the various known motive powers at the disposal of the foundry industry.

### Motive Powers Available.

Despite all endeavours, electricity, either through magnets or applied through the medium of gears, cannot yet be said to be a serious competitor to pneumatic or hydraulic methods. It must be accepted that in such a case as the sand-slinger type of machine, the use of electric motors is a necessity, but in this contribution it is not proposed to deal with this type of machine (which, strictly speaking, is not at all a complete moulding machine), but with the definite types of machines which fulfil completely not only the ramming of the moulds but also the pattern drawing. Various difficulties, such as direct current or alternating current, appear when endeavouring to use electricity, and the fact that voltages and supply of electricity varies in almost every county throughout the country, means that each machine, even if electricity could be universally used, would have to be built especially to suit the existing current and voltage in the various users' works, and it is evident that this would increase the cost of the machine enormously, and so consideration will be restricted to the two well-known agencies:—(*a*) Compressed air and (*b*) hydraulic power.

### Motive Powers to Use.

One fact must be mentioned at this stage, namely, that there are some cases when compressed air is the better power to use and others when hydraulic power is superior. These cases can be briefly summarised as follow:—

The use of compressed air is always advocated when a jolting action is necessary. This immediately opens up a controversy as to whether it is better to jolt or squeeze a mould, or whether it is better to do both, viz., jolt and squeeze. To clear up the matter in a few words, in the writer's opinion, (*a*) jolting only should be used where one has deep pockets of sand to ram, such as in the case of the long-ribbed radiator pipe of the Continental type, or where any deep narrow parts of sand have to be definitely rammed. The same remarks apply to the jolt-squeeze type of machine—the only function the squeezing is fulfilling in this case is to ram tightly the top part of the mould after jolting, and eliminating the flat or butt ramming by hand, which is always necessary after jolting. Ingot moulds or long cylindrical patterns should be always jolted or jolt squeezed; (*b*) efforts have been made on many occasions to discount the benefits to be derived from plain squeezing and many attempts have been made to bring out alternative means to obtain perfectly rammed moulds by other means, at somewhere approaching the same rapid speed. Up to the present these efforts have generally failed, and it is still accepted in America and in Europe that where a plain squeeze can be applied, it is not only quicker but also gives a superior mould. Within the last few years the application of the down-sand frame, whereby the pattern is pushed into the sand (instead of the sand into the pattern) and drawing the pattern on the exhaust stroke of the piston, has revolutionised mechanical moulding by pressure, and certainly this method is, without doubt, the most interesting and progressive step which has been made in mechanical moulding within the last decade. By its aid, castings as shallow as flat stove plates or as deep as baths, etc., can equally well be rammed at a speed which is extremely high.

In addition, bars in a box are solidly rammed underneath, without any hand tucking, and this fact alone is a great progressive step in mechanical moulding, and, as far as the writer knows, this under-bar ramming cannot be carried out by any other means of mechanical ramming. A further advantage is that moulds have not to be strickled after ramming. It takes valuable seconds to strickle rammed sand. When using the down-sand frame, the box is strickled before ramming, that is to say, the loose or unrammed sand is simply scraped off, which is, obviously, much quicker and easier to accomplish.

These points, which perhaps might be termed as a "wandering" from the title of this article, are necessary to bring forward when considering the motive power. It will thus be seen that:—(1) Compressed air can be used for squeezing alone, jolting alone or jolt-squeeze combined. It can also be used when squeezing only with the down-sand frame. (2) Hydraulic pressure serves its best purpose when used for squeezsure serves its best purpose when used for squeezing only, particularly when used in conjunction with the down-sand frame. At the same time, certain definite facts must be borne in mind when considering which power to adopt.

Compressed air in foundries is generally found at a maximum pressure of 70 to 90 lbs. per sq. in. Thus, if the ideal moulding of squeezing only is to be obtained, the diameter of the cylinder has to be increased considerably, in order to give the necessary total pressure to the mould. Against this hydraulic pressure is usually available at a pressure of 750 lbs. per sq. in. up to very high pressures, thus the cylinders can be considerably less than the pneumatic ones to obtain the same pressure.

The cost of producing compressed air is extremely high. If users would only go into the cost of horse-power to produce the air necessary for the machines, the author is certain that they would find good reasons for checking the consumption. There is no doubt that compressed air is the most expensive power in existence. Against this, hydraulic power is probably the cheapest power known to man. It is not intended to enter into long details to prove this, but suffice to say that in the foundry with which the author is connected twenty hydraulic moulding machines, including several fairly large ones, are all driven with a 5-h.p. motor, whereas two very small compressed-air machines are using over 10 h.p.

Much has been said about leakages in hydraulic installations. It is certainly true that if a leak occurs in a hydraulic main, with, say, 1,000 lbs. pressure per sq. in., it certainly is a source of mess and inconvenience. Can it be said that compressed-air lines never leak, and if they do are they noticed? If a hydraulic leak occurs, steps must of necessity be taken to stop the leak, but if compressed-air leaks happen, very often they are allowed to go on, either intentionally or otherwise, and at a high cost. It, perhaps, is not generally known that a ¼-in. hole in a pipe line, with compressed air at 75 to 80 lbs. per sq. in., will take approximately 20 h.p. to overcome this leakage.

Much has also been said about freezing of the water in hydraulic installations during winter. It must be admitted straight away that this is a disadvantage to the hydraulic installations, but is it not a fact that this danger is greatly over-exaggerated? Condensation in pipe lines of compressed-air installations has also to be watched during the winter months. In either case, only very severe conditions would cause a break, and care should be taken in both cases to drain the pipe lines and machines if the weather is sufficiently severe to warrant it. It must also be remembered that if the weather was so severe as to freeze up the machines, it would also freeze up the sand in the foundry and work would not be possible. Generally speaking, anyway, in these Islands we do not have to face such severe conditions. A definite case of freezing with air plant was brought to the notice of the author during a recent severe winter. The water in the water jacket around the air compressor froze up and caused a considerable amount of trouble. In the same foundry a number of hydraulic-moulding machines, on the same day, were perfectly free from frost, due to the fact that in most cases working parts were underground and the frost could not get at them, and above ground they had been protected. Here was a definite case where frost caused stoppage with the air machines but no stoppage with the hydraulic machines.

Another definite factor must not be forgotten, namely, that if the weather were so severe as to freeze up the moulding machines and the water under high pressure in the pipe lines, all the general mains, containing drinking and washing water, would be frozen. How often in this country do we experience such conditions? It is just as easy to protect the pipe lines to and from moulding machines as it is the general washing and drinking mains. Again, to-day modern standard hydraulic machines can so very easily be emptied of the water that a little care will avoid all risk, a risk which the author believes has been grossly over-exaggerated in the past.

There can be no question that the smoothest and easiest way to draw a pattern is by the use of a fluid medium. Compressed air is very jerky in its movements, and hydraulic power alone allows the sweet, steady pattern-drawing motion which is essential, especially where difficult and intricate parts of sand have to be drawn free from breakage.

To sum up the entire question, it will be seen that both compressed air and hydraulic power have their advantages and disadvantages. The author holds no brief for either power, as the company with which he is connected with make machines to work with either power. There is room for both agencies in every foundry, the only thing to study is to use the correct power in the correct place and under the most advantageous conditions.

* Mr. Beech is a Director of Messrs. Universal System of Moulding & Machinery Company, Limited.

## Educational Opportunities for Young Engineers.

At this time of the year, during the long vacation of the technical schools and colleges, the Council of the Institute of Marine Engineers desire to remind young engineers and apprentices of the educational advantages afforded by association with the Institute. Apprentices or students intending to become marine engineers are admitted as graduates on furnishing proof of apprenticeship and studentship at a recognised technical school or college.

The Institute's annual examination for student graduateship and the accompanying diploma, open to graduates and others not yet associated with the Institute, will be held on April 13 to 16 next at centres arranged to suit candidates. The superintendent engineers of the leading shipping companies recognise that possession of this diploma is proof of all-round ability in the technical subjects specially required as the foundation of a successful career as a marine engineer.

Of particular appeal to ambitious and studious apprentices is the annual offer of the Lloyd's Register Scholarship, value £100 per annum and tenable for three years at an approved university. The next examination for the scholarship will be held on May 11 to 12, 1931, at various centres. Full particulars may be obtained from the Secretary, Institute of Marine Engineers, 85, The Minories, London, E.C.3.

# A Discussion on Bronze Founding.

## THE ROLE OF SULPHUR.

Mr. F. W. Rowe's Paper* on "The Founding of Bronze Gear Blanks," presented to the recent Middlesbrough Conference, formed the background for a general discussion on the melting and metallurgy of copper alloys.

### SULPHUR IN CAST BRONZE.

#### Discussion.

Mr. H. C. Dews, who opened the discussion, stated that there were few people who could presume to dispute with Mr. Rowe over the subject of gear blanks, because it was a subject he had made especially his own and brought to bear a large amount of careful thought and experimental work. He raised a point, however, in connection with coke for melting phosphor-bronze, and the sulphur content of that which he used in the reverberatory furnace. He (Mr. Dews) had been melting phosphor-bronze in a similar type of reverberatory furnace to the author's, and had found that the quality of the coke was of fundamental importance, but not before had he understood that the sulphur content was of such significance. It had always seemed that hardness, reactive values, density and porosity were all very important, and were of more value than sulphur content. As a matter of fact, the effect of sulphur on bronze was rather a controversial subject, and one about which he had thought a good deal. Mr. Rowe has stated that if he had high-sulphur coke, the sulphur in the bronze gave increased shrinkage. Was he speaking in a vague uncertain way or had he chapter and verse for that statement? He had never been able to find sulphur in bronze, and he had tried to introduce sulphur into bronze to ascertain the effect, but he had never been able to do so yet. One or two other people have been trying the same thing. Messrs. Röntgen and Schwietzke published some research work recently in the Zeitschrift für Metallkunde, in which they investigated the zinc bronzes, and they reported that they could not get sulphur into bronze. When they added sulphur they only got a sulphide scum, suggesting a reaction between sulphur dioxide, copper and tin which produced copper sulphide and tin oxide. These rose to the top, and if the bronze melt was properly skimmed it would be removed. They did not mention shrinkage. If there had been any excessive shrinkage they would have noticed it, because they made a number of test-bars and performed a number of mechanical tests, but did not find any marked effect of sulphur. Again, Bolton and Wiegand reported in the Technical Publication No. 281 of the American Institute of Mining and Metallurgical Engineers on the same subject, and they stated that the effect of sulphur was not marked. Their experiments were even more searching than the Germans, in that they made a type of pressure test-bar. They formed a lump of metal and machined the inside out to test for porosity with water, and if the sulphur had brought about any excessive shrinkage that test would have discovered it. He was inclined to agree with these results because he had never been able to get sulphur into bronze.

#### Coke Consumption in Reverberatory Furnaces.

The figures Mr. Rowe gave for coke consumption appeared to be remarkably good. He should like to have confirmation of his surmise that these referred to heavy ingot metal and scrap, and that they did not refer to melting borings. If melting light or dirty scrap or borings, the coke consumption would be rather higher. He noticed also that Mr. Rowe used a protective covering when melting ingot metal. His own view led him to adopt a different practice. The protective flux covering of bronze was rather more of a hindrance than a help. Firstly, one had to skim it off and lost metal, and, secondly, he had never yet been able to find a slag which was so good for bronze as a properly-regulated atmosphere. From a suitably-built coke fire one got conditions which seemed to be very good for bronze. He had never found any slag or covering which was as good for bronze as this perfectly-adjusted coke-fire atmosphere. He would not use any other, but if the author could indicate any advantage from a flux covering, further details as to what particular composition he used would be welcome.

In several places in the Paper Mr. Rowe had referred to bronze when he obviously was referring to phosphor-bronze. This was just a little indiscretion in nomenclature, but there was a case where he used the word bronze instead of phosphor-bronze, which might lead to considerable misunderstanding of what Mr. Rowe was referring to, as he mentioned sand castings, which after solidification had a density of 8.4 to 8.5. The whole of that paragraph and the preceding one would have to be rewritten if he were speaking of zinc-bronze, so that perhaps it would be as well if he stated that he was referring solely to phosphor-bronze on that page.

#### Core Practice.

Another point dealt with was the use of cores and the greater difficulties encountered with spinning sand cores than with stationary ones. Many other people had found difficulty in using oil-sand cores, due to the particularly searching nature of the bronze, in that the core cracked, the bronze entered into the cracks, and unsightly fins were found inside the castings. One could overcome this by using some thick refractory wash, but that was both troublesome and expensive. It would be interesting if the author would divulge a little more detail of the preparation of cores, and if he had any trouble due to the metal penetrating the cracks.

#### Structure of Spun Bronze.

Mr. J. M. Primrose said he had already commented upon the use of the centrifugal casting of bronze, and that from the photo-micrographs they had seen it was obvious that the chief difference lay in the almost complete elimination of the usual dentritic structure associated with ordinary sand castings. It was remarkable that although the chill casting largely prevented the eutectoid separation, and left coring which seemed to contain some beta constituent residual, the centrifugal casting, on the other hand, seemed to produce no diminution of the amount of separated eutectoid. The question of the amount of sulphur necessary to be absorbed to produce excessive shrinkage was interesting, and it had always appeared to him better to melt bronze in an oil-fired furnace to prevent this occurrence. The ordinary zinc-bronze was less susceptible than brass in absorbing sulphur from gases in the furnace, and it was possible phosphor-bronze was not immune, even with some protective covering. For this purpose he had advocated a layer of charcoal rather than any flux, and very little loss of metal was caused in this way. There was no doubt that under certain conditions of loading it was the physical constitution rather than the chemical composition which gave the best results in a bronze gear wheel, and in this connection he regretted the absence of the usual physical test data which would serve to round off and complete the usefulness of the Paper as a work of reference. No doubt these had been published before, but it meant they had to be searched for if not included in a small appendix. Impact and abrasion values might be included with the ordinary tensile strengths to compare the ordinary with spun castings.

#### Fluxing for Bronzes.

Mr. A. Logan commented on the question of sulphur content of bronze being of great interest, as he thought there was some difficulty in estimating sulphur in phosphor-bronze. He could not be dogmatic on the matter, but he had analysed a good number of bronzes and found sulphur present. He agreed with Mr. Rowe about using a covering, and had found charcoal as was stated by Mr. Primrose to be the most useful. There was one question he would like to ask; in the case of chill castings one obtained the suppression of the delta separation, in fact in certain cases one found no free delta present. Whilst one had similar cooling conditions in spinning as in the chill, had Mr. Rowe any theory to account for the presence of the delta-eutectoid in centrifugal castings. It seemed to him that they should expect very little separation under these conditions.

#### Factor of Design.

Mr. A. Harley gathered from the Paper that for gear-wheel blanks, centrifugal castings were superior to any other type of casting. Some people, however, were getting good results from sand-cast gear blanks, some from chilled-cast gear blanks, and many are getting excellent results from centrifugally-cast gear blanks. If one sought for the explanation why all three methods of casting may give good results, his view was that the method of casting was only one factor of the story. In gear blanks the method of machining, design of the teeth, and sufficient strength in regard to section of the finished casting and the relation to the load are all-important factors. To-day designers were expecting more and more out of castings, increasing the load on the gears, and very often forgetting to make any extra provision in regard to strength of section. In this way one came to the point that the factor of safety was lower now than it ought to be through expecting the gear to do too much because the same design was carrying an increased load. The success or otherwise of bronze gear wheels, therefore, was not entirely dependent on the casting itself. It should not only be sound and free from defects, but also have good strength in regard to tensile. Whilst good tensile figures are generally indicative of good mechanical properties, they are not the only consideration. Resistance to crushing of the structure was more important still. Perhaps in time he would be able to confirm the idea whether or not centrifugally-cast bronze was superior for that particular purpose, but he had to admit that centrifugal-cast gear-blanks were making headway. In conclusion, he wished to express his appreciation of Mr. Rowe's Paper which had been presented for their discussion.

### AUTHOR'S REPLY

Mr. Rowe, in responding, expressed himself as deeply indebted to the members present for their kind remarks on his effort.

Regarding Mr. Dews' remarks on the quality of the coke necessary for this class of reverberatory furnace which is so usually used for heavy tonnages of metal to be melted with great rapidity, he should mention that the mechanical as well as the physical properties of the coke were of vital importance for this furnace. In fact it was impossible to get good results unless high-class coke were used. One of the main features of the coke necessary for this type of furnace which he should mention was that it should have a "dry" ash. If the ash melted at 1,500 deg. C. it stopped the free passage of the draft and made for very irregular operation and slow melting, and consequently the coke should be hard and dense.

In regard to sulphur content of bronze, he could assure Mr. Dews that his remarks were based on actual experience. On many occasions they had considerable trouble, and from bitter experience they knew that there was no question that it could absorb sulphur, and did so. The

* Published in our issues of June 19 and 26.

normal amount of sulphur found in bronze melted in this type of furnace is something of the order of 0.003 to 0.005 per cent., whereas they reached a sulphur content as high as 0.05 to 0.06 per cent. when using coke having sulphur of 1.3 to 1.8 per cent. Mr. Logan seemed to confirm this from his analyses, which were presumably done by the gravimetric and not the evolution method. Their search had been carried out after experiencing excessive shrinkage of metal under the risers.

The low value of the coke figures used in melting were, of course, for ingot metal, and as Mr. Dews said, they would be a good deal higher if light scrap or borings were being melted. In regard to a protective covering, he had certainly found considerable advantage in using a cover to prevent oxidation. In the reverberatory furnace he used a special heavy charcoal, as the ordinary type of wood charcoal would simply blow away when the blast was put on. Practically all zinc-free bronze should be melted with some suitable form of covering. The criticisms in regard to nomenclature were quite justified, and certain of these would be rectified in the Paper before it reached the Proceedings.

Mr. Dews had also raised the point of using sea sand in cores for bronze containing an appreciable amount of phosphorus. This was a trouble which everybody encountered in phosphor-bronze, but most people took the line of least resistance and so used oil-sand cores. That would have been rather useful except for the fact that we could not use oil-sand cores for this centrifugal process. It was only after much experimental work that it was possible to get a core-making arrangement for this type of work, in which the job had to be watched from start to finish, in order to get the core to withstand the heavy wash of metal, and be sufficiently strong. It resolved itself chiefly into a question of the correct bonding material and drying temperature, whilst incorporating a double refractory wash. The mixture of sand could be varied according to the size of core required, and therefore no definite formula would answer for every class of casting. If the requirements were not for centrifugal castings, it was not a difficult matter to overcome, because then it was only necessary to overcome the erosion of the metal. With two or three days' experimenting with sand mixtures and the best drying temperature for the bond, one could get quite satisfactory cores, and, of course, the higher the casting temperature of the phosphor-bronze, the greater the eroding effect.

Mr. Primrose had raised the question of dendritic structure in ordinary phosphor-bronze and, of course, personal arguments were based on a very extensive series of mechanical tests, checked on all sizes of castings, and in all cases test-pieces had been taken directly from gear blanks and not from separately-cast bars. In no physical property was the centrifugally-cast metal inferior to the sand cast, and in practically all of them decidedly superior. The important matter in regard to the size of dendrite in chilled castings compared with centrifugally-cast ones was the very great improvement in shock strength shown by the latter. Ordinary chill castings were very deficient in shock strength, whereas centrifugal castings gave a fine structure which was particularly high in resisting shock. He was sorry that he had omitted to include physical test values, and a table of these would be included.

Mr. Primrose had also commented upon the suppression of the alpha-delta eutectoid in ordinary chilled castings, and had asked if some of the cored structure might not be beta. In very few instances had he been able to trace the presence of any beta constituent. Only in one or two cases had this been detected by means of the surface-scratch hardness test.

Mr. Logan had drawn attention to the difference between the amount of alpha-delta contained in the structure of chilled castings compared with centrifugal castings, which had a partial chill. He would not like to be too dogmatic about the explanation, although he was quite sure from repeated examination as to the resultant effects. It was apparently due to the rate of cooling. In ordinary chilled castings there was a very rapid rate of cooling in the chilled part, and, subsequently, slow cooling inside, and this differential rate is the one which seemed most likely to suppress the alpha-delta eutectoid separation. In centrifugal casting one had a rapid rate of cooling throughout the whole range of the cooling, and whilst the relative amount of delta in centrifugal castings might not really be more than in fully-chilled castings, yet the relative proportion in, say, a 1 in. dia. phosphor-bronze stick might be exactly the same as in a centrifugal casting if this rapid rate of cooling could be maintained all the way through, when one would automatically get the correct proportion of alpha-delta separation.

Mr. Harley had stated that a great many sand and chilled castings had given excellent results in service, and he agreed that this was perfectly true. One must admit that one could get almost any sort of sand casting of sound phosphor-bronze to give satisfaction provided the loads are sufficiently light. He claimed his firm to be the largest producers of gear castings in this country, and the present output of centrifugal castings was greater than any other type. The factor of safety nowadays was almost non-existent, varying from 1.1 to 1.0, and in abnormal cases of overloading the result led to failures. The factor of safety was now so small and designers were constantly putting up engine speeds and torques and not allowing anything for the increased stresses. The chassis and other parts were, therefore, having more duty put upon them, and that was why for their own satisfaction they had proceeded to perfect a casting which would meet any severe service. Many of the heavy loads, which would produce failures in gear-wheel castings if made in sand or chills, would be successfully met if it were a centrifugal casting. His firm were forced into the adoption of this process because they were up against the difficulty of meeting the designers' heavier loads and increased gear work without any increased size, and it was up to them as gear makers to produce a bronze which would withstand these increased stresses.

## The Duplex Steel Process in Germany.

Herr A. Jung (of Peine) in "Stahl und Eisen" describes the carrying out of the duplex process in Germany. According to him, 22.71 tons of pig-iron and 2 tons of scrap are charged in the basic Bessemer converter and the charge blown. Next the open-hearth furnace is charged with 4.15 tons of steel-making pig-iron from the Ilsede plant, 6.35 tons of heavy scrap, 3.1 tons of light scrap and nearly 2 tons of turnings; 1 ton of limestone is added to this. After two hours, a charge of 22.1 tons from the basic converter is poured in, the composition of this being carbon 0.025, manganese 0.30, phosphorus 0.124, sulphur 0.039 per cent. The charge is ready for tapping at the end of another hour. The yield is approximately 36 tons of ingots, of which the composition is:—Carbon 0.09, manganese 0.26, phosphorus 0.02 and sulphur 0.027 per cent. Fuel consumption in coal is reported as 12.03 per cent. of the weight of the steel produced, which compares favourably, says the author, with a fuel consumption of 19 per cent. in the scrap-pig-iron process.

No additions were made in blowing the converter charge, but 184 kgs. of 80 per cent. ferro-manganese, 14 kgs. of spiegel, 10 to 12 per cent. Mn and 21 kgs. of 80 per cent. ferro-silicon were added to the charge in the open-hearth furnace.

Production of steel by this process was raised from 180 tons per 24 hrs. by the ordinary process to 280 tons per 24 hrs. Economy in fuel and increased output are, however, offset partly by the use of manganiferous pig-iron in the open-hearth, this costing more than scrap.

# High-Strength Cast Iron=Eutectic Cast Iron.*

### Advantages of the Eutectic Alloys.

By Prof. E. Osann.

To this postulation should be added the statement that all phenomena relating to cast-iron structure must be covered by one underlying principle. The laws of eutectics and of the nuclei theory serve for this purpose.

The lecturer utilised the solidification diagram of the lead-antimony system to demonstrate the eutectic theory in order to explain the iron-carbon diagram which carries the chemical compound $Fe_3C$ and takes into consideration the formation of mixed crystals, graphite being temporarily disregarded.

Graphite appeared in the diagram of cast iron as soon as an appreciable amount of silicon appeared in association with carbon. The other "iron" constituents Mn, P, S may at present be left out of consideration as long as the usual amounts are present.

As soon as silicon enters the alloy there is the tendency towards the separation of graphite, the latter appearing in the hypo-eutectic alloy as primary and as secondary graphite, the latter being a decomposition product of the compound $FeC_2$ below the solidus. In the eutectic composition there is no primary graphite, only secondary. In hypo-eutectic compositions, as for example in malleable castings, no graphite is present, and only after subsequent annealing is graphite, or rather temper-carbon, precipitated.

The lecturer then dealt with the advantages of the eutectic alloys. The alloy is easily cast, is less inclined to piping and possesses in the cast condition the best properties for resisting stresses, whilst being easily machinable because the absence of crystalline aggregations favours the arrangement of the molecular structure in a state of equilibrium. Other examples were given, amongst which were type metal, the cylinder and roll iron, and especially the charcoal pig-iron for direct casting, and which latter the lecturer drew upon from his own practical experiences. He described its advantages when casting from heavy patterns and also when making art castings.

He insisted that it should be the aim of foundry executives to produce eutectic cast iron. This can be achieved in that the formation of the primary graphite is suppressed, the more so as this is always detrimental. This can be achieved by correct adjusting the carbon contents together with the silicon contents. The lecturer demonstrated this by lines drawn into the iron-carbon diagram. The formation of pearlite and fine-grained graphite can be explained from the course of these lines to the pearlite point.

If the problem is production of light castings, such as radiator, the primary graphite must also be eliminated as far as this is possible, but, on the other hand, an endeavour must be made, by adjusting the silicon content, to maintain the required softness of the cast iron. The graphite in this case will be similar to that in grey-charcoal pig-iron and will be as soft as the former.

The lecturer, in answer to a question, insisted that neither the superheating nor jolting of cast iron would give results equal to those obtainable from eutectic cast iron, explaining this phenomena on metallurgical grounds.

A higher phosphorus content results in a highly fluid iron. This brought the lecturer back to the origination of the eutectic iron. The formation of a more uniform grain in foundry pig-iron, which is high in phosphorus, is explained in the same manner.

* Abstract of a Paper read before the German Foundry Technical Association.

## Steel-Plant Lubrication.*

By W. A. James.

Reliable tests of a reversing-mill engine have proved that about 30 per cent. of its power is employed in the actual rolling process; about 27 per cent. in overcoming friction of the engine parts; another 13 per cent. in combating roll journal friction; and some 9 per cent. in overcoming pinion and spindle friction. The remaining 21 per cent. is used in producing acceleration of the parts in reversing. As this analysis indicates, only 30 per cent. of the total power shows up usefully in the product, while friction absorbs 49 per cent.

The steel industry as a whole offers an enormously wide variety of lubrication problems. When a study of the maintenance cost on bearings and gears in a steel plant points to the conclusion that in many instances about one-half the power required for rolling steel is used to overcome the friction between parts, the full utilisation of recent designs and means of lubrication opens up a vista of rather startling possibilities.

Important advances have been made in lubricating practice. In some form or other, modern lubricating systems and methods are rapidly replacing older methods. One of the most outstanding of these is the so-called "circulating system," which is becoming the chief method of lubrication for the most modern steel mills. It includes a main supply line, with branches to the various elements to be lubricated, a common return line to take the individual returns from each element, a suitable tank for receiving and cooling the return oil and separating water and heavy impurities from it, and a means of cleaning and purifying the oil, as well as storage capacity for the clean oil. An excellent opportunity has been provided by this system to study both the economy of the lubricant and the life of the pinions and bearings. The results of its operation have been much better than expected.

A second, comparatively new, method of lubrication is what is known as "forced feed" lubrication. This has proved the solution to many problems, particularly those involving individual machines such as punches, drills, and others, where operation is intermittent. Systems of this kind are operated at varying pressures from the machines to which they are attached. The forced feed pumps can be constructed with any number of oil feeds, which can be piped to the different bearings. The amount of oil supplied to each bearing can be accurately regulated through adjustment of the stroke of the pump plungers to suit the individual bearing requirements. These oil pumps, driven from some moving part of the machine, only operate when the machine is running.

A case is called to mind of one entire rolling mill equipped with a "forced feed" system of lubrication. This reaches every individual bearing on motors, drive, roll housings, tables, manipulators and all auxiliaries. The oil is circulated, cooled and filtered. Its supply is so interlocked with main control that if the circulation should, for any reason, be interrupted, the entire mill closes down. It is claimed that this system is so efficient that make-up oil amounts to about 30 cents a day, or roughly what one oiler might easily waste in an hour. The particular virtue of this system is that it eliminates the uncertainties attendant upon lubrication by the older methods. This mill, generously designed in all parts, although by no means new in any respect, operated throughout 1928 with total delays chargeable to failures in equipment amounting to only 19 min.

A third form of lubrication developed only within the past few years and now coming into rather general application, is the "centralised system," which uses either oil or grease. Manually operated once or more often during the day, it forces the lubricant to the bearings on the machine or equipment. Its application has been particularly successful with respect to individual machines, and it has developed into a useful method of lubricating overhead cranes. Its main advantage is that it is applicable to many operations where either the nature of the operation, or the initial expense involved, precludes the installation of a "forced feed" system.

### Application to Steel Plants.

In a large steel plant the question of lubrications presents many different aspects, due to the large number of different operations, each requiring its particular lubricant and method of lubrication. Perhaps the major aspect of the lubrication question in a steel plant is lubrication of the roll necks. A lime-soap base grease with about 6 per cent. of manufactured graphite, to which a light steam-refined cylinder oil is usually added, has proved a satisfactory lubricant for roll-necks. The density of the grease for roll-neck lubrication is regulated according to the speed of the rolls, the hardest grease being used on the low-speed necks.

Lubrication of vertical rolls has presented some special difficulties in the past. This has been particularly true of their bottom bearings, since these were split at the bottom, enabling the lubricant to run out. Use of a bushing type of bearing, closed at the bottom, now effectively prevents this. Grease, applied through a pressure fitting on the bottom end of the bearing, and able to work out of it only by passing upward between the top flange of the bearing and the shoulder of the roll, is now used as a lubricant in these cases. This improved design both provides effective lubrication and keeps water and scale out of the bearing. Bearings so constructed run for months without being changed, in contrast to those of the older design, which often had to be changed every few days.

Mill pinions, until quite recently, were lubricated by being swabbed with a heavy-bodied pitch or still-bottom residue, which was considered necessary to take the shock from the teeth during the rolling operation. The advent of higher speeds, and of herring-bone pinions constructed of high-carbon steel, made improvement in the methods of lubrication essential. Pinions in certain mills now run in a bath of asphalt-base grease, the density of which is determined by the speed at which the pinions run, the heavier consistencies being used with the slower-speed mills. The pinion necks are lubricated with a heavy oil by means of a "forced feed" pump, while provision is made for supplying oil through a gravity system in an emergency. The pump is driven direct from the pinion neck, and operates only when the pinions revolve.

* From a Paper read before the American Iron and Steel Institute, at New York.

## Properties of Steel.

### RATING OF CHEMICAL ANALYSIS.

In the course of a Paper, read before the American Iron and Steel Institute at New York recently, Dr. Johnston pointed out that rigid analytical specifications were distinctly less justifiable in the purchase of materials of construction which were used because of their physical or mechanical properties. In this case the purchaser was really interested in the structure of the material supplied; and need not care what elements were present provided that the material fulfilled his requirements as to mechanical qualities, such as strength or ductility. This led one to wonder whether chemical specifications had not attained their present vogue because it had proved to be more difficult to set up entirely adequate physical or mechanical tests.

### Chemical Analysis and Finished Products.

That chemical analysis of a steel, as ordinarily carried out, should not always correlate satisfactorily with the quality of the finished steel product (continued the author) may be due to the fact that the chemical analysis has not gone far enough to be completely effective. For while one may determine the percentage of A, B, C and D (for instance, carbon, sulphur, phosphorus, manganese) one may be omitting E and F (for instance, nitrogen, oxygen, hydrogen, non-metallic inclusions), because E and F are thought to be present in such small proportion as to be without influence, perhaps, too, because the method of determination is slow, troublesome or unsatisfactory. But a very small proportion of E or F in the liquid steel may exert an influence comparable to the use of an iron catalyst in the synthesis of ammonia, a little glue in a plating bath, or to the "salting" of crystallising solutions.

There is no reason in principle why this same effect should not appear in the crystallisation by freezing of molten metal, causing differences in the resulting aggregate or conglomerate making up the solid piece of metal, or in the changes taking place at the so-called "critical" temperature range of steel. In fact the whole of the important phenomena taking place at this range are essentially changes in the physical architecture of the metal, and are not accompanied by any change in "chemistry."

Another possibility to be considered is the difference which may result from a different distribution of a fixed proportion of a component, as determined by analysis. For example, an amount of about 0.90 per cent. carbon may be present in iron in at least four modes of distribution. It is well known that the machining properties of such a material vary greatly with the mode of distribution of the carbon, the chemical composition being identical.

Another example is the mode of distribution of non-metallic inclusions, which are generally recognised as being more undesirable in relatively large masses than when the same total proportion is scattered through the metal.

### Chemical Specifications too Exacting.

Since the quality of the final metal depends not only upon its "chemistry" but also upon what is done to it after it leaves the furnace, and that the chemical analysis is admittedly incomplete—it seems as if too precise chemical specifications are, in the present state of knowledge, not always justified. As a specific instance, the upper limit of allowable sulphur is often set at 0.04 per cent.; yet a committee of the American Society for Testing Materials, after careful investigation, concluded that sulphur may go as high as 0.077 per cent. in plates (the highest percentage examined), and 0.06 per cent. in rivets, without showing any systematic relation between any of the properties determined and the percentage of sulphur within the limits stated.

It may be that sulphur is, in a sense, a symptom rather than a cause, that the steel is better merely because it was worked long enough in the furnace to bring the sulphur within the prescribed limits; on the other hand, some seem to be of opinion that the methods necessary to bring these elements below a low limiting percentage may yield a steel less well adapted to its purpose than it would have been, if finished at a somewhat higher level. However this may prove to be, the precise limits specified appear to be the result of trade practices rather than of a conclusion based on really comparable experiments designed specifically to answer unambiguously the question at issue.

**Labour Conditions in Belgian Quarries.**—Mr. D. Pitt, a partner in Anglo-Belgian Refractories, of 53, Solihull Lane, Hall Green, Birmingham, has written us a letter confirming the statements made by Messrs. Pittevill & Company, and adds that between 66 and 70 per cent. of the price paid in England for Belgian sand goes to the British transport companies.

# Metal Melting by Oil Fuel.

By W. C. Cathcart.

The demand for better working conditions and shorter hours on the part of labour has led to many improvements in metal-melting furnaces, particularly from the point of view of speed and cleanliness in working. The management, being primarily concerned in the reduction of melting costs, realise to-day the losses they may incur as the result of old-fashioned, slow and dirty methods of melting, and the difficulty of controlling workmen employed under unhygienic conditions. Both masters and men are anxious to adopt improvements in melting methods.

### Pit Furnaces.

The old-fashioned crucible coke-pit fires have the undoubted advantages of low first cost, and are specially suitable for dealing with an output comprising a varied range of alloys. Labour costs, however, are high, and the furnacemen's task is dirty and arduous. The output of metal for a given floor space is low; much valuable room must be set apart for the storage and breakage of fuel, and for clinker dumps, added to which the ashes must be treated for recovery of spilt metal if loss of metal is to be kept down to a low figure.

### Tilting Furnaces.

An important step forward in the direction of economy was made when coke-fired tilting-crucible furnaces were introduced, enabling charges up to half-a-ton to be melted with a considerable saving in fuel and floor space. Nevertheless the difficulties and discomforts of the work of fuel charging and clinkering have still to be faced, though not perhaps to the same degree. Cleanliness in the foundry is incapable of achievement while solid fuel is used for melting, and for real improvement in this direction recourse must be had to gas, electricity or oil.

### Gas.

There are several designs of pit and tilting-crucible furnaces on the market for working on town's or producer gas. Heat in the form of town's gas costs at least three times as much as that in the form of coke or oil, and the furnaces are apt to be noisy in operation. Producer gas is much cheaper on a cost per thermal-unit basis, but the gas-making plant and fuel storage take up a large amount of space, and expert supervision is required, failing which the quality of the gas made is liable to considerable variations. Without elaborate waste-heat recuperators, it is difficult to attain with producer gas flame temperatures sufficiently high for rapid working and for melting the more refractory metals.

### Electricity.

Melting electrically is admirable from the point of view of cleanliness of working and the amenities of the furnace operators. Many improvements have been made during recent years, but owing to the relatively high cost of heat in this form, particularly in this country where electricity has to be generated from steam power, progress is slow and likely to remain so. The majority of electric furnaces are costly to install, and as most of the more efficient types lack flexibility, they can only be effectively employed where there is a large and regular output of standard alloys.

### Oil.

Liquid fuel, a by-product of the ever increasing production of petrol for automobiles, is now available in enormous quantities, and offers many advantages for melting. In the first place, it has a high calorific value and can be burnt in one or other of the many patterns of burner in a confined space in a simple pit or tilting furnace, and temperatures sufficiently high to melt mild steel or pure nickel can be attained without recuperation. The temperature builds up as the heat progresses, without any of the periodic set-backs that must occur when coke furnaces have to be re-coked or clinkered. Melting time is therefore reduced, and the furnacemen can be sure of attaining the requisite temperature punctually. It is chiefly on this account that oil furnaces employ usefully a much larger proportion of the total heat in the fuel than coke furnaces. As regulation is effected by the turn of an oil needle-valve or air shutter, the amount of attention required is much less than in the case of a coke furnace, where the fire will burn into holes unless the coke bed is maintained solid by frequent poking. The difficulty of pokering and clinkering coke-fired furnaces limits their size, and it is a difficult matter to obtain satisfactory results in coke furnaces above ½-ton brass capacity. With oil furnaces, on the other hand, it is if anything easier to fire big units than small ones. A large number of 15-cwt. tilting oil furnaces are now in regular use, and still larger sizes are now being put on the market. These big units are particularly convenient for dealing with heavy or bulky scrap, without costly breakage or cabbaging.

A furnaceman can melt more metal a day in an oil furnace than in a coke furnace, and can often look after two units where one coke furnace would be all he could manage. It is often found that the cost of melting labour per ton of metal is reduced by as much as 50 per cent. when oil is substituted for coke. Oil fuel can be stored in underground tanks, and the amount of heat units per cub. ft. of storage space is well over twice that for coke. There are no clinker deposits to be removed, washed for recovery of spilt metal, and carted away.

TABLE I.—*Melting Results on 70/30 Brass in ½-ton Crucible Furnaces.*

| Fuel. | Calorific value. | Cost per ton. | Cost per therm or 100,000 B.T.U. | Weight required to melt 1 ton of brass. | Cost per ton of brass. | Therms per ton of brass. |
|---|---|---|---|---|---|---|
| | B.T.U./lb. | s. d. | Pence. | Cwts. | s. d. | |
| Coke .. .. | 13,500 | 49 0 | 1.95 | 3½ | 8 6 | 52 |
| Oil .. .. | 19,000 | 65 0 | 1.84 | 2 | 6 6 | 42 |

### Fuel Costs.

It is evident that the direct labour charges for operating oil furnaces and the somewhat indeterminate but by no means negligible costs of handling fuel and refuse are far less with oil than with coke, but one must now ascertain to what extent, if any, these savings are offset by other factors. The first point to consider is the relative costs of fuel per ton of metal. Fuel oil used in reasonable bulk now costs 65s. per ton delivered in the London area, while a good brand of foundry coke costs 49s. per ton in the same area. As will be seen in Table I, this substantial difference in cost per ton is outweighed by the greater heat content of a given weight of oil, and by the fact that owing to the simpler and more continuous combustion the heat developed is more effectively applied. Table I shows the relative costs of melting brass in a modern high-capacity crucible-tilting furnace.

The advantages of oil-fired furnaces are leading a considerable number of firms to convert their coke-fired pit or tilting furnaces to oil firing, and this fuel is now being specified for a large and rapidly-increasing proportion of new metal-melting equipment.

### Cost of Furnaces.

The cost of an oil-fired furnace with all the necessary burner equipment, tank pipes, etc., is usually a little higher than that of a coke furnace of similar capacity, but the difference is offset by the more self-contained nature of the oil unit. In other words, while the actual furnace costs rather more, the outlay on foundations, flues and chimney is considerably less.

### Cost of Renewals.

The two chief items under this head are crucibles and refractory linings. Both are subject to erosion by coke-fuel slag, the wear around the bases of the crucibles and lower courses of the fire-brick lining depending on the nature and fusibility of the ash of the fuel. In the case of oil firing, as the fuel is practically ash free, erosion caused by the fuel is negligible, any that occurs being generally due to the attack of metal spilt over the side during charging or pouring. The leading crucible makers adjust the composition of the mixture to suit the special conditions obtaining in oil furnaces, and the life of such pots is generally greater than in coke fires, due to the reduction of external erosion.

### Reverberatory Furnaces.

It will have been observed that these notes apply primarily to crucible-melting furnaces, which are almost universally used for the more costly metals required to be melted under those conditions best calculated to ensure maximum strength and reliability in the casting. These notes, however, would not be complete without reference to non-crucible or reverberatory type furnaces, the use of which can be justified under exceptional circumstances, *e.g.*, in shipyard foundries, where occasionally a very large weight of molten non-ferrous alloy is required for such heavy pieces as a ship's propeller, or again where large quantities of borings or ash metal have to be run down and fluxed for ingoting and re-melting. By care in design many of the drawbacks of this type of plant, in which there is close contact of flame with the charge, with risk of oxidation, overheating and sulphur contamination, can be minimised. Here again, well-designed *oil*-fired reverberatory furnaces have been proved to give results very appreciably superior to the similar type fired by coal or coke. The readily-controlled oil burners can be adjusted so as to minimise overheating and burning of the metal, and the heavy loss of zinc that occurs when alloys bearing this ingredient are not protected from direct flame contact.

### Quality of Metal Melted.

There is less risk of dirt inclusions and sulphur contamination in metal melted by oil owing to the cleaner conditions obtaining and the purer nature of the fuel. On the other hand, no matter how carefully the oil and air supplies are adjusted, the atmosphere in an oil furnace tends to be less strongly reducing than in the case of a coke furnace, where for the greater part of the heat, carbon monoxide is present in quantity in the waste gases. It is therefore usual to protect bronzes and brasses when they have reached the semi-molten condition by a thin layer of crushed charcoal.

### Where Oil Firing is Suitable.

Below are enumerated the conditions specially favourable for oil firing:—(1) For all valuable metals, *e.g.*, pure nickel or high nickel alloys, where any loss of metal in the ashes would be a costly matter; (2) for aluminium, both for melting and maintaining furnaces, where dirt inclusions from solid fuel are difficult to separate from the metal when pouring, and

(*Continued on page* 80.)

# The Reclamation of Oil-Sand Cores.

By Frank Hudson.

(*Continued from page 58.*)

**Effect of Casting Temperature on Core Sands.**

The effect of casting temperature on core sands in regard to the "splitting up" of sand grains is most important from the reclamation viewpoint. Quartz has a strong tendency to crack at a temperature around 575 deg. C. (1,067 deg. Fah.) due to strains set up by an inversion change in the quartz from one phase to another. The smaller the grain, the less liable is shattering to take place. Dierker,[4] in a recent Paper, has shown that the temperatures reached by a fairly high silica sand when used for casting a steel block 1 in. × 8 in. × 8 in. is only around 800 deg. Fah. at 1 in. distance from the metal face and 400 deg. Fah. at 2½ in. distance. A block of steel three times the thickness reached temperatures of 1,300 deg. Fah. and 750 deg. Fah. at like distances. It is obvious from this that in general foundry practice the temperature reached by the bulk of the sand grains is not high. Dierker also shows quite definitely that the effect of steel temperature in regard to the splitting-up of the sand grains is only apparent to any noticeable extent on those gains coming in contact with the metal.

[4] Foundry Trade Journal, February 13, 1930, page 121.

Table II.—*Leighton Buzzard Sand Mixture.*

A.—Burnt sand adjacent to casting after first cast.
B.—Old returned sand including addition of "A" after first cast.
C.—Burnt sand adjacent to casting after second cast.
D.—Old returned sand after second cast.

Sieve Tests.—Passes Mesh.

| Sample. | 20 | 30 | 40 | 60 | 80 | 90 | 100 | 120 |
|---|---|---|---|---|---|---|---|---|
| New sand.. .. | 94.5 | 73.9 | 34.6 | 4.8 | 1.9 | 1.7 | 0.4 | 0.3 |
| A .. .. | 96.4 | 75.9 | 43.8 | 10.5 | 6.0 | 5.5 | 2.7 | 2.3 |
| B .. .. | 93.8 | 51.1 | 19.9 | 2.3 | 1.6 | 0.7 | 0.3 | 0.2 |
| C .. .. | 94.8 | 64.7 | 30.3 | 4.7 | 2.5 | 2.0 | 1.0 | 0.8 |
| D .. .. | 95.1 | 69.7 | 27.9 | 5.4 | 2.8 | 2.7 | 1.3 | 1.1 |

Physical Tests on cores made from used sand.

| Sample. | Lbs. per sq. in. | | Perm. in sec. | Gas evolved. c.cs. per grm. | |
|---|---|---|---|---|---|
| | Tensile. | Transverse. | | 850 deg. C. | 1,200 deg. C. |
| New sand alone .. .. .. .. | — | — | — | Nil | Nil. |
| New sand plus 3 per cent. by weight binder | 377.0 | 77.06 | 35.0 | 8.85 | 14.80 |
| Returned sand after first cast .. .. | — | 9.27 | — | — | — |
| Returned sand after first cast plus 2 per cent. binder by weight .. .. .. | 255.0 | 44.68 | 35.0 | 14.98 | 21.57 |
| Returned sand after second cast .. .. | Cores too weak to handle. | | | | |
| Returned sand after second cast plus 2 per cent. binder by weight .. .. .. | 251.0 | 38.54 | 35.0 | 15.62 | 22.90 |

Binder used—"Glyso" 444 grade.
Test cores baked at 400 deg. F.

Table III.—*Southport Sea-Sand Mixture.*

Sieve Tests.—Passes Mesh.

| Sample. | 20 | 30 | 40 | 60 | 80 | 90 | 100 | 120 |
|---|---|---|---|---|---|---|---|---|
| New sand.. .. | 99.2 | 98.8 | 96.7 | 83.9 | 32.0 | 30.8 | 5.8 | 3.4 |
| A .. .. | 99.8 | 99.3 | 97.6 | 79.2 | 27.1 | 20.4 | 4.4 | 2.6 |
| B .. .. | 99.2 | 96.7 | 88.8 | 57.1 | 18.5 | 13.1 | 3.5 | 2.0 |
| C .. .. | 99.0 | 98.7 | 95.3 | 72.1 | 25.8 | 21.5 | 4.6 | 2.7 |
| D .. .. | 99.5 | 99.2 | 96.2 | 76.8 | 30.4 | 22.5 | 6.1 | 4.3 |

Physical Tests on cores made from used sand.

| Sample. | Lbs. per sq. in. | | Perm. in sec. | Gas evolved. c.cs. per grm. | |
|---|---|---|---|---|---|
| | Tensile. | Transverse. | | 850 deg. C. | 1,200 deg. C. |
| New sand alone .. .. .. .. | — | — | — | — | 10.50 |
| New sand plus 3 per cent. by weight binder | 303.0 | 56.52 | 55.0 | 22.22 | 32.59 |
| Returned sand after first cast .. .. | — | 7.88 | — | — | — |
| Returned sand after first cast plus 2 per cent. binder by weight .. .. .. | 427.0 | 51.62 | 50.0 | 26.23 | 38.80 |
| Returned sand after second cast .. .. | Cores too weak to handle. | | | | |
| Returned sand after second cast plus 2 per cent. binder by weight .. .. .. | 176.0 | 29.81 | 48.0 | 30.71 | 36.42 |

Binder used—"Glyso" 444 grade.
Test cores baked at 400 deg. F.

Table IV.—*Removal of used Binder from reclaimed Core Sand (Leighton Buzzard) by Mechanical Treatment.*

Sieve Test on sample as received.—Passes Mesh.

| 20 | 30 | 40 | 60 | 80 | 90 | 100 | 120 |
|---|---|---|---|---|---|---|---|
| 89.40 | 57.22 | 25.92 | 7.59 | 2.74 | 2.67 | 0.25 | 0.11 |

Gas content on sample as received .. .. .. .. .. .. = 12.2 c.cs. per grm. at 850 deg. C.
" " " rubbed for 10 min. and retained by 60 mesh sieve = 5.2 " " " "
" " " rubbed for 20 min. and retained by 60 mesh sieve = 4.2 " " " "
" " " rubbed for 30 min. and retained by 60 mesh sieve = 4.0 " " " "
" " " rubbed for 30 min. passing 60 mesh sieve .. = 8.7 " " " "
13.36 per cent. of sand passes 60 mesh sieve as received.
20.36 per cent. of sand passes 60 mesh sieve after 20 min. rubbing.
79.64 per cent. of sand retained by 60 mesh sieve after 20 min. rubbing.

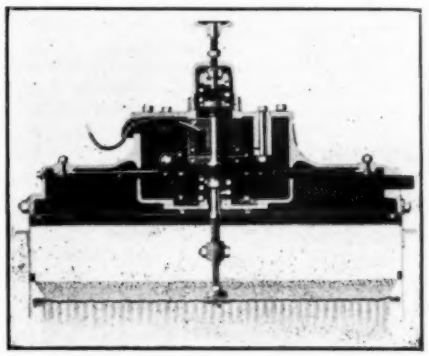


Fig. 5a.—Demonstrates how the Hum-mer uses all its Surface.

Material stratifies with coarse on top and fines hugging the screen cloth.

This is confirmed by general observations at the National Steel Foundry at Leven. This company have successfully used reclaimed sand for years, and Mr. Hamilton, works manager, who has made a particular study of the question, considers that only the surface of the oil-sand core which comes in contact with the molten steel has its sand grains fractured. He finds that the sand which comes in contact with the steel is fused to a depth of $\frac{1}{16}$ in. and leaves the casting as a powder. Beyond this point for a depth of approximately $\frac{1}{4}$ in. some of the sand grains are split, and these, together with the

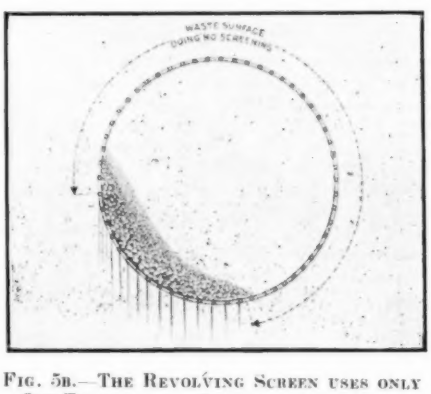



Fig. 5b.—The Revolving Screen uses only One-Third of its Surface at any time.

The coarse material hinders the fine material.

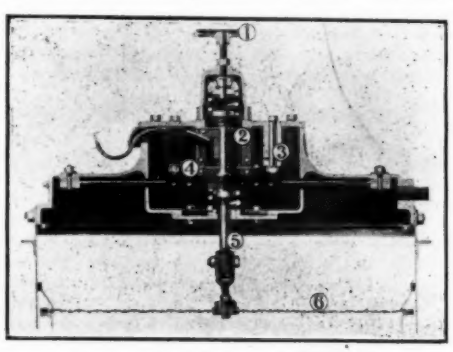



Fig. 6.—The Hum-mer Screener.

(1) Hand wheel for regulating intensity of vibration; (2) coil and magnet; (3) striking block, wearing plate and shims; (4) armature; (5) armature post and bracket; (6) wire cloth at drumhead tension coupled to armature post.

powdered grains, are removed before re-using. Of course, the depth of unusable sand varies according to the weight and type of casting, and the above remarks refer to light and medium work. To obtain further confirmation on this point the following practical experiment was conducted by the writer.

TABLE V.—*Specification for Core Sands. (Cast Iron.)*

*For Special Jacket Cores.*

Bulk of sand grains should be between 30 and 60 mesh, and not more than 3 to 4 per cent. should pass 60 mesh. The sand should preferably be washed and it must evolve no gas, or show signs of fritting on heating to temperature of casting. The ideal sand should consist of all its grains 40 mesh size. All cores made from the above sand should preferably be black-washed if good finish is desired.

*For General Purpose Work.*

Bulk of sand grains should be between 40 and 60 mesh, and not more than 20 per cent. should pass 80-mesh sieve. The sand must evolve no gas or show signs of fritting on heating to temperature of casting. The ideal sand should consist of all its grains 60 mesh size.

*For Light Hardware Castings.*

Bulk of sand grains should be between 60 and 90 mesh, and not more than 40 per cent. should pass 90-mesh sieve. The sand must evolve no gas on heating to temperature of casting. The ideal sand should consist of all its grains 80 to 90 mesh size.

A mould was made to the dimensions shown in Fig. 4 from an oil-sand core mixture, and cast with hot grey iron. Two kinds of sand were tested, namely, Leighton Buzzard, No. 6, and Southport sea sand. After casting, the sand was examined closely and tested for grain size, permeability, etc. The old sand was now made up into further moulds *without* the addition of new sand, but with further binder additions, and re-cast. The results obtained are shown in Tables II and III. It was hoped that the sands under test could have been re-cast at least 10 times, but unfortunately only two casts could be obtained in the time available. However, the results show that the sand grains only "split up" very slightly when used for cast iron. Of the two sands tested, this is perhaps shown most clearly in Table II relative to Leighton Buzzard, as this sand is more uniform in grain size than Southport.

The observations that can be drawn from this test are as follow:—(1) "Splitting up" of sand grains is extremely slight after two casts and the majority of split grains are those lying adjacent to the casting; (2) the relative permeability of the core sand is not affected by alteration in grain size; (3) the grains in new core sands "split up" more readily than after the sand has been used; (4) the greatest danger in employing untreated old oil-core sand lies in the increased evolution of gas, this gas evolution becoming greater and greater after each cast; (5) the permeability of cores made from untreated old oil-core sand is reduced due to this extra evolution of gas; (6) no reclamation of binder is feasible when cores are required for cast iron, except after the first cast, and in those cases where large lumps of unburnt cores (print ends, etc.) are obtained; and (7) as the core sand gets older it requires increased binder percentages to obtain a given strength.

It would appear that the splitting up of silica grains is not a serious matter in the two sands tested, although this cannot be accepted definitely for all core sands as variation is probable. On the other hand, it is perfectly obvious that a very real danger exists, due to the excessive amount of gas evolved on casting, from old sands which are used without removal of the carbonaceous matter present from decomposition of the oil binder.

### Practical Reclamation Methods.

As pointed out previously, the type of plant required for reclamation is primarily determined by the kind of castings made. For iron and steel founders, the reclaimed sand must be equal to or even better than when in its natural condition. The case for general non-ferrous work is not nearly so particular, and, naturally, the initial plant outlay is considerably reduced, and in many cases satisfactory reclamation can be practised with the ordinary sand-handling plant common to modern foundry practice. For the production of high-class reclaimed sand, the most economical method is the dry method, using either heat or mechanical treatment to remove the burnt binder, followed by suitable grading by screens or sieves or by employing an air classifier to remove silt and fine grains of detriment to the final product.

### Removal of Unburnt Binder.

For this operation two principal methods, producing satisfactory results, are those using:—

1. *Heat.*—The old sand and core pieces are rough crushed, irons and sprigs removed and then passed through a rotary kiln or barrel-type furnace. This method is certainly most effective, but the working cost is high, and it is essential that the heating source be cheap and the kiln or furnace well designed. Every possible consideration should be given relative to the initial crushing operation as this obviously affects the heat consumption, as if the core pieces are too bulky, then more heat is required for disintegration. Furthermore, it is essential to have oxidising conditions present inside the kiln to permit of quick removal of the binder, and efficient means of spreading the sand to prevent packing. In this manner 100 per cent. of the binder can be removed.

2. *Mechanical Action.*—By the use of mechanical means it is feasible to remove 60 to 70 per cent. of the burnt-binder constituent The principle employed consists of imparting a light-rubbing action to the old sand in a suitable mill, followed by grading through screens. The rubbing action must not cause excessive disintegration of the sand grains. Table IV illustrates the result of experimental work in this direction. A sample of used Leighton Buzzard core sand was obtained and lightly rubbed, without crushing, in an iron pestle and mortar for 10, 20 and 30 min. After each time period the sand was passed through a 60-mesh sieve and the amount of gas evolved determined on that portion remaining on the sieve. It is obvious from Table IV that considerable possibilities can result from this treatment. Whilst a certain degree of sand-grain reduction is bound to take place, it is feasible to recover at least 70 per cent of reclaimed sand, free from fines and silt and of a low gas content. It is essential, however, to remove the fine material by sieving, as this contains the bulk of the carbonaceous matter, and a grading operation becomes part and parcel of the reclaiming process. The old sand, furthermore, must be dry before treatment, and kept dry during treatment.

After removal of the carbonaceous matter it is advisable to classify and grade the sand to obtain a uniform-grained material, free from fines. This can be satisfactorily performed by the use of screens or by what is known as air classification.

### Grading and Classifying.

*Screens.*—The most satisfactory type of screen for general-purpose work is undoubtedly the electric-vibrating type, after the Hum-mer principle, as illustrated in Fig. 2. These screens are particularly suitable for foundry work, as they require the minimum of attention and have no moving parts. They do not require oiling and the screen itself can be replaced in a very short time. Furthermore, they are extremely efficient and deliver the maximum quantity of material per square foot of screen surface. In this respect they are superior to the revolving-round type and also handle material faster, as the finer material tends to lie adjacent to the screen

TABLE VI.—*Sieve Tests made with Tyler Standard Screen Scale Sieves.*

*Material:* Foundry sand. *Description:* Free screening. *Date:* December 10, 1926. *Test No.:* 4262.1. *Made by:* E.B. *Moisture:* None.

| Screen scale. Ratio $\sqrt{2}$ or 1.414 | | | | (A) Feed. | | | (B) Product air-reclaimed sand. | | | (C) Hum-mer product through 8 mesh on 50 m. | | | (D) Hum-mer product through 50 monel. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time: 3 minutes. | | | Time: 3 minutes. | | | Time: 3 minutes. | | | Time: 3 minutes. | | |
| Openings. | | Mesh. | Diam. wire inch. | Weight between sieves. | Per cent. between sieves. | Cum. per cent. (Total per cent. on each sieve.) | Weight between sieves. | Per cent. between sieves. | Cum. per cent. (Total per cent. on each sieve.) | Weight between sieves. | Per cent. between sieves. | Cum. per cent. (Total per cent. on each sieve.) | Weight between sieves. | Per cent. between sieves. | Cum. per cent. (Total per cent. on each sieve.) |
| Inch. | Mm. | | | | | | | | | | | | | | |
| 0.065 | 1.651 | 10 | 0.035 | 70.8 | 6.1 | 6.1 | 4.0 | 0.7 | 0.7 | — | — | — | — | — | — |
| 0.046 | 1.168 | 14 | 0.025 | 6.8 | 0.6 | 6.7 | 2.0 | 0.3 | 1.0 | 0.3 | 0.1 | 0.1 | — | — | — |
| 0.0328 | 0.833 | 20 | 0.0172 | 10.2 | 0.9 | 7.6 | 2.5 | 0.4 | 1.4 | 2.3 | 0.5 | 0.6 | — | — | — |
| 0.0232 | 0.589 | 28 | 0.0125 | 87.3 | 7.5 | 15.1 | 40.5 | 7.0 | 8.4 | 50.0 | 11.4 | 12.0 | — | — | — |
| 0.0164 | 0.417 | 35 | 0.0122 | 418.6 | 36.2 | 51.3 | 255.2 | 44.0 | 52.4 | 208.0 | 47.5 | 59.5 | All pass | | |
| 0.0116 | 0.295 | 48 | 0.0092 | 285.3 | 24.6 | 75.9 | 162.0 | 27.9 | 80.3 | 136.0 | 31.0 | 90.5 | 19.7 | 8.0 | 8.0 |
| 0.0082 | 0.208 | 65 | 0.0072 | 183.7 | 15.8 | 91.7 | 86.7 | 14.9 | 95.2 | 36.0 | 8.2 | 98.7 | 126.3 | 51.7 | 59.7 |
| 0.0058 | 0.147 | 100 | 0.0042 | 44.2 | 3.6 | 95.3 | 18.5 | 3.2 | 98.4 | 4.7 | 1.0 | 99.7 | 46.3 | 18.9 | 78.6 |
| 0.0041 | 0.104 | 150 | 0.0026 | 25.5 | 2.2 | 97.5 | — | — | — | — | — | — | 27.4 | 11.2 | 89.8 |
| 0.0029 | 0.074 | 200 | 0.0021 | 16.0 | 1.4 | 98.9 | — | — | — | — | — | — | 12.9 | 5.3 | 95.1 |
| 0.0000 | 0.000 | Pan | | 12.8 | 1.1 | 100.0 | 9.3 | 1.6 | 100.0 | 1.5 | 0.3 | 100.0 | 12.8 | 4.9 | 100.0 |
| | | | Totals | 1159.2 | 100.0 | | 580.7 | 100.0 | | 438.8 | 100.0 | | 244.6 | 100.0 | |

THE W. S. TYLER CO., CLEVELAND, OHIO.

surface (Fig. 5B). These screens are ideal for reclamation purposes, as they work totally enclosed and the products can be easily collected. Fig. 6 illustrates a sectional drawing of this type of equipment. In some cases it has been found practical to incorporate fixed screens on certain types of reclamation plant, but, as a rule, it is advisable to invest in a separate unit. In regard to the mesh of screen required, it is usually necessary to employ two screening surfaces. The top surface retaining lumps or sand grains of a too coarse nature, whilst the second retains the usuable material and the fines pass through this second screen for waste disposal. Table V gives a general idea of the sizes of sand grains required for different classes of work, and the screen mesh used should correspond accordingly.

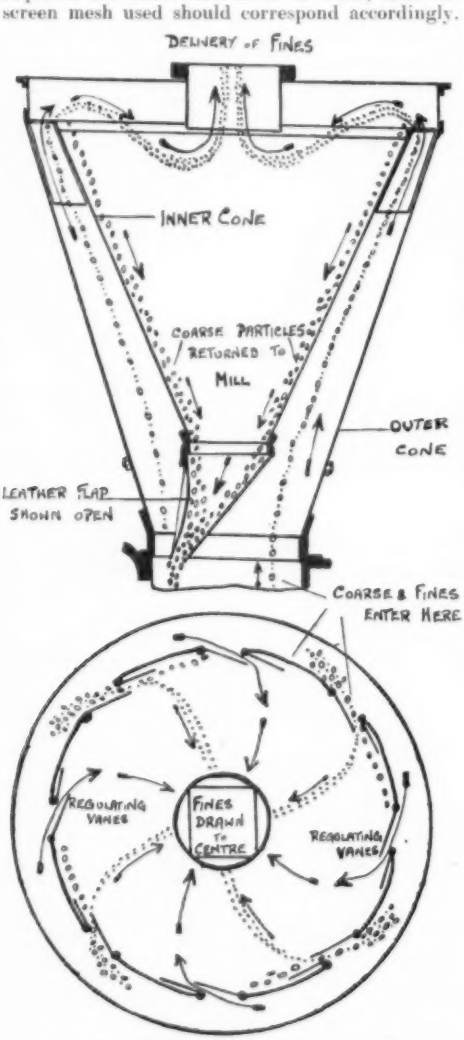



Fig. 7.—Raymond Air-Separating Plant.

*Air Classification.*—The principle of air separation for the grading of reclaimed sands has found considerable favour in America. The action of air separators depends on the relation between the velocity of a stream of air and the limiting dimensions of the sand grains or silt particles it will entrain. It is possible to calculate the air velocities required to separate different-sized sand grains by the use of formulæ familiar to makers of this type of equipment. By starting with an air velocity sufficient to entrain the largest particles and then gradually decreasing the velocity, the particles separate out in the order of their diameters. Gradual-decreasing velocities are obtained by design and incorporation of baffle-plates. Fig. 7 illustrates the internal construction of an air separator. The construction consists of a feeder which also acts as a base. On the top of the feeder is mounted the air separator proper which grades the sand. The fines are drawn from the separator through a pipe by an exhauster. The separator itself consists of two cones, one inside the other, with an annular space between. The material on entering the system through the feeder is picked up by the air stream, carried upwards between the cones and enters the inner cone through a series of ports. To each port is attached a pivoted vane, which can be revolved from the outside and placed at different angles to the periphery of the inner cone. By placing the vanes at an angle to the periphery the air stream on entering the inner cone is given a cyclonic motion. The material, in the air stream, therefore, becomes acted upon by centrifugal force, which tends to project it to the periphery, away from the central outlet of the separator. The air velocity in the inner cone is reduced, due to larger cross-section. The fines are carried away in the air at the centre outlet and by controlling the vanes the separator will produce a sand of a relatively uniform grain size, according to the air velocity. With most types of air separators it is usually necessary to incorporate a dust collector.

For practical purposes screening is definitely productive of the most uniform results, although the difference is not great. By courtesy of the International Combustion Company this is confirmed by Table VI. It is perfectly feasible, furthermore, that in particular instances it would be possible to incorporate a single-surface screen with a modified form of dust collector, when the classifying or grading of reclaimed core sand would be obtained by both methods. The removal of the burnt binder and the grading of the sand into grains of uniform size constitute the two major essentials of any reclamation process. Auxiliary equipment of proved benefit would consist of magnetic separators for the removal of iron particles.

In conclusion, the author wishes to thank Major Athey, managing director of The Fordath Engineering Company, Limited, for granting permission to conduct the laboratory work necessary for this Paper; to those American colleagues of the American Foundrymen's Association who gave so freely of their experience, and to those British firms who so kindly obliged with descriptions of their plant.

## Metal Melting by Oil Fuel.

(*Concluded from page 77.*)

where temperature control is particularly important; it is difficult to guard against overheating such easily-melted charges in coke furnaces; (3) for melting under the best metallurgical conditions in large units; (4) for foundries where space is limited, and transport of fuel is costly and difficult, and (5) for foundries where continuous day and night working is necessitated.

### Oil-Furnace Installation and Equipment.

Oil is normally fed to the burners by gravity from a small feed tank fixed near the furnace. If the oil is of a type that thickens when very cold, some provision should be made for warming it in winter after a week-end stop. A filter for removing suspended dirt is generally necessary, and oil-supply pipes on the large side are usually worth their slight extra cost. The oil should be atomised by air, preferably at a pressure between 8 to 16 ounces per sq. in., derived from a single- or two-stage high-speed fan. The fan has to revolve at high speed and is therefore rather noisy, and should in consequence be installed if possible outside the foundry. As the oil flame will melt steel without preheating the air supply, and as it is advisable to keep the installation as simple as possible to avoid maintenance costs and complications in operation, it is not customary to provide for waste-gas recuperation. Flues are not necessary to the operation of the furnace, though if the foundry is confined they may be advisable for hygienic reasons.

## Activities of the German Foundry Technical Association.

In the report of the German Foundry Technical Association, the Secretary (F. Bock, mining engineer, of Berlin) states that the membership has considerably increased and is at present 1,630 members. The partial or complete closing down of many foundry plants resulted in the number of members unemployed being again considerably increased. The Appointments Bureau, organised by the Association, had, consequently, been frequently used by its members.

Thanks to the co-operation of many eminent experts, "Die Giesserei," the official organ of the Association, has achieved a really important position as a unified publication covering all German foundry associations.

The Association has published during the past year a "Bibliography of Electro-Metallurgy of Ferrous Metals." This treatise has been compiled by the Electric Furnace Committee of the Association and edited by Prof. Dr. Kothny. It offers to all interested parties a complete and valuable bibliography of the subject.

The Association also instituted, at the beginning of this year, a translation service, in order to keep its members in constant touch with all the important foreign developments.

Special attention has been given during the past year to the development of the library, with the intention to make it a reliable source of technical knowledge for the members. The index of books and periodicals has been greatly increased compared with last year.

The Association held during the past year a number of important meetings, amongst them a membership meeting at Düsseldorf in connection with the fifth German Trades Exhibition, at which various technical Papers were read.

The report also states that the branches of the Association had again been very active, which resulted in the widening of the knowledge of their members and which gave fresh inducements for the advancement of the industry. A sub-section at Mannheim was constituted last December at the express desire of many foundrymen residing in the district. A second sub-section was formed last June in the Saar region. Both branches made, during the short time of their existence, under the energetic leadership of their chairmen, excellent progress and have already given proof of their activity.

The Electro-Furnace Committee has held a special meeting, at which the following problems were discussed:—(*a*) Quality control in electric steelworks; (*b*) the coreless induction furnace; (*c*) output figures of American electric furnaces; (*d*) the production of synthetic grey cast iron in electric furnaces, and the production of grey castings in the acid electric furnace.

The committee is at present engaged upon the results of a questionnaire relating to electrodes of various origin and their behaviour under various working conditions.

Other committees are engaged upon the study of high-duty cast iron and moulding-sand control. Special attention has again been given by the Association to the development of non-ferrous foundry practice. Scientific work and propaganda of the Non-Ferrous Foundry Committee occupy a large space in the report. It may be specially mentioned that at present the committee has considerably enlarged its programme and has been entirely reconstructed.

The Committee on Foundry Apprenticeship has issued during the past year general rules for the training of foundry apprentices, in order that the boys may be sure of acquiring a thoroughly practical knowledge of their trade.

There are further reports relating to the activity and the present position of the Coke Committee, the Standardisation Committee and many other committees in which the German Foundry Technical Association is co-operating with similar technical associations.

# The Moulding of Flat Castings at the Usines Godin, Société du Familistère de Guise, Colin & Cie, Guise.*

By H. Magdelenat.

The Usines Godin, who specialise in the manufacture of heating and kitchen apparatus, possess an original type of plant for moulding the principal castings required for this purpose. The machine about to be described dates from 1875. It was designed by Godin and developed between 1875 and 1880. It was destroyed during the German invasion, but has been partially reconstructed and a battery has again been in operation since 1926. Its arrangement enables castings to be moulded when the relief does not exceed 10 cm.

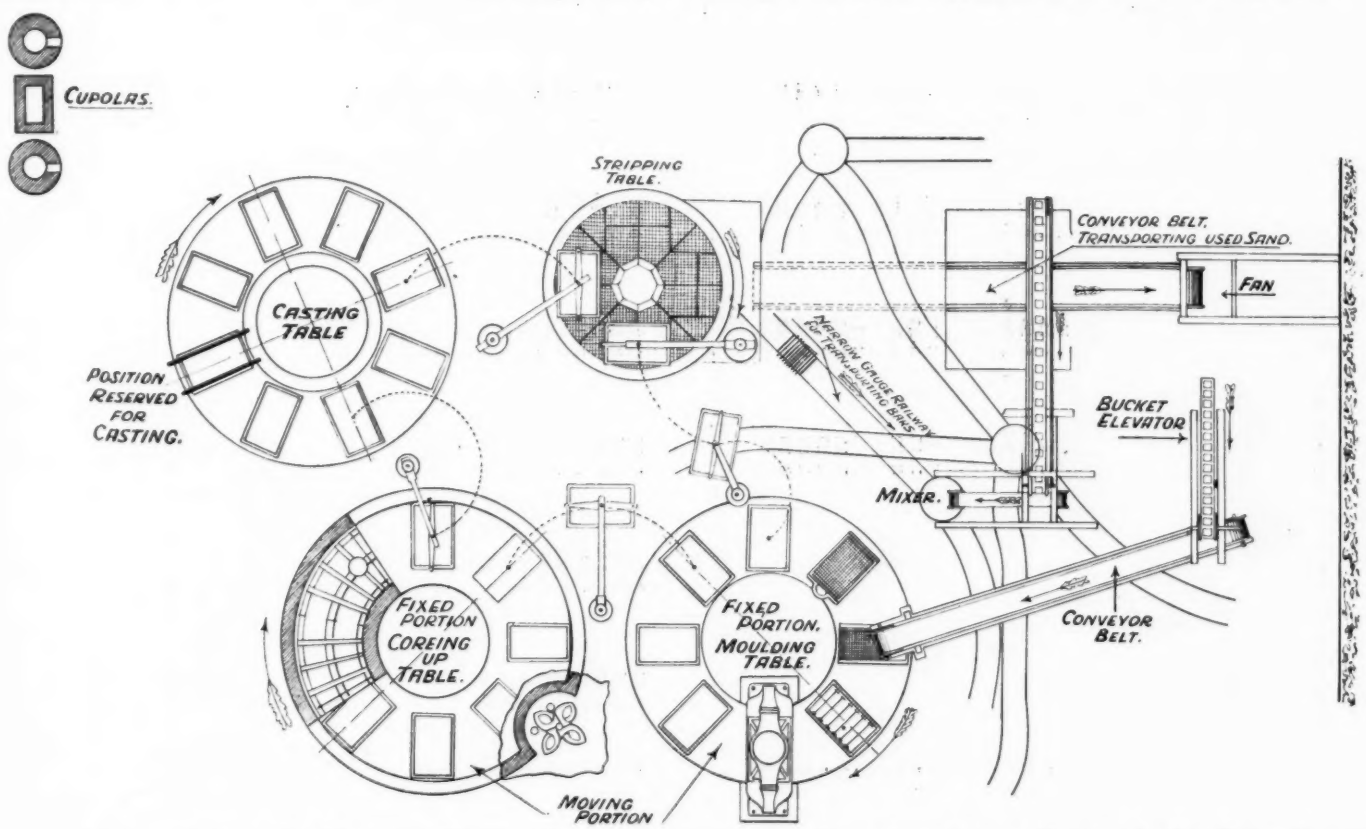



FIG. 1.—LAY-OUT OF THE MECHANICAL MOULDING BATTERY INSTALLED AT THE USINES GODIN FOR THE MOULDING OF FLAT CASTINGS.

The moulding is done on pattern plates measuring 1.5 by 0.94 m. These are made in the works themselves, and are arranged so as to take as many castings as possible forming part of the same apparatus.

The mechanical moulding battery comprises four turntables arranged as shown in the accompanying diagram, Fig. 1. They comprise a table for moulding, one for coring up, one for casting and one for stripping. The moulding boxes are transported from one table to another by hydraulic cranes.

The operation of the machine may be studied by following a moulding box in its passage to the different tables. Eight pattern plates are arranged on the moulding table in such a manner that two successive plates are intended to form the two complementary parts constituting a complete moulding box.

One moulding box having been placed on the pattern plate, a workman arranges the runners and risers. The box is then supplied mechanically first with the facing sand and, after the table has been given a one-eighth turn, with the backing sand.

After the bars for keeping the rammed sand in place have been inserted, the moulding box passes beneath the hydraulic press which imparts the requisite pressure.

It should here be noted that the moulding turntable and the coring-up table are moved one-eighth of a revolution at a time. The movement is controlled by the raising of the squeezing mechanism, and the stopping is automatic. A fresh moulding box is thus automatically brought under the press and in front of the cranes after each rotation.

A workman removes the runner sticks, and the moulding box is then brought in front of the crane. It is then raised by four studs which strip it without noticeable vibration from the pattern plate, after which it is taken up by the crane and transported on to the coring-up table. Here specially-trained men repair any parts that may have broken off in stripping, insert the cores and completely finish the moulding box.

On being transported to the casting table the parts of the moulding box are assembled in pairs. The movement of the casting table, which is independent of that of the first two tables, brings the box beneath a clamping device which gives the necessary rigidity during the pouring. As the place reserved for casting is very near the cupola, this operation—the only one not performed mechanically—is nevertheless executed with a minimum of effort.

Continuing its course, the box arrives in front of the crane which transports it to the stripping table. It is by this time sufficiently cooled for stripping. The top of the stripping table takes the form of a grating with 1.6 in. square holes. The moulding box, held about 4 in. above the board by four supports, is knocked out. The castings are removed and the gates broken off. The empty box is taken up again by the crane and brought back to the moulding table, where it begins a fresh cycle. All the good castings are taken direct to the cleaning and trimming shops.

The circuit made by the sand is as follows: After having sprinkled it with water, a workman works it through the checkerwork of the table. It is mixed for the first time and is then lifted by an endless belt conveyor, cooled by ventilation and transported by a bucket elevator to the upper part. Here it is mechanically prepared and, having been made fit for moulding again, it is conveyed to distributing hoppers which serve the moulding boxes.

The production of the machine is one moulding-box part per minute, or 30 complete boxes an hour, the average production of good castings being 5 to 6 cwts. an hour. It should be noted that the castings in question are thin and light in weight. The complete crew consists of 30 workmen. The work is not arduous, and enables the labour required for the machine to be easily recruited from among men whose health or strength has been impaired or whose productive capacity is feeble.

It may be noted also that this machine constitutes the oldest example of continuous mass-production work, for it has been in operation for over 50 years.

* Part of a Paper presented at the Annual Convention of the Institute of British Foundrymen on behalf of the French Foundrymen's Association, of which the author is Vice-President.

**Nitriding Symposium in America.**—Hardening steel by nitriding will again be the foremost topic for discussion at the National Metal Congress, to be held at Chicago, September 22 to 26. The tentative list of papers to be presented at the Congress contains 34 entries, of which five deal with various phases of nitriding.

# The Economic Utilisation of British Pig-Iron Resources.

(*Continued from page 65.*)

## District "D"—Cleveland—*continued.*

| Index No. | Firm or Works. | Type. | Designation, Grade or Brand. | | COMPOSITION. C. Combd. | C. Gr. | C. Total. | Si. | S. | P. | Mn. | Other Constituents. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29 | WHITWELL & CO., MIDDLESBROUGH. | — | Not working for several years. | | | | | | | | | | |
| 30 | WARNER & CO., Cargo Fleet. | | "WARNER C.B.R." (Cylinder Pig Iron)— | | | | | | | | | | Approximate analyses can be varied in certain respects to suit special requirements. Each grade can be supplied in soft, medium and hard fractures. |
| | | C | No. 3 .. .. .. .. | A | — | — | 3·4 | 1·85 | 0·03 | 0·10 | 0·70 | — | |
| | | C | No. 4 .. .. .. .. | A | — | — | 3·25 | 1·25 | 0·04 | 0·10 | 0·50 | — | |
| | | C | No. 5 .. .. .. .. | A | — | — | 3·0—3·25 | 0·90 | 0·05 | 0·10 | 0·45 | — | |
| | | C | Mottled .. .. .. .. | A | — | — | 3.0 | 0·2—0·70 | 0·05 | 0·10 | 0·40 | — | |
| | | | REFINED PIG for Malleable Castings— | | | | | | | | | | |
| | | R | "O.K." White .. .. | A | — | — | 3·15 | 0·55 | 0·20 | 0·06 | 0·40 | — | — |
| | | R | ,, Medium Mottled .. | A | — | — | 3·20 | 0·80 | 0·18 | 0·06 | 0·40 | — | — |
| | | R | ,, Soft Mottled .. | A | — | — | 3·25 | 1·00 | 0·18 | 0·06 | 0·45 | — | — |
| | | | "SPECIAL O.K."— | | | | | | | | | | |
| | | R | ,, White .. .. | A | — | — | 3·20 | 0·35 | 0·05 | 0·06 | 0·40 | — | — |
| | | R | ,, Medium Mottled .. | A | — | — | 3·20 | 0·70 | 0·05 | 0·06 | 0·40 | — | — |
| | | R | ,, Soft Mottled .. | A | — | — | 3·30 | 0·95 | 0·05 | 0·06 | 0·45 | — | — |
| | | R | ,, C.P. White .. .. | A | — | — | 3·50 | 0·15 | 0·03 | 0·06 | 0·30 | — | — |
| | | R | ,, C.P. Hard Mottled .. | A | — | — | 3·50 | 0·25 | 0·028 | 0·06 | 0·30 | — | — |

## District "E"—Lancashire.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31 | CHARCOAL IRON CO., LTD., ULVERSTON. (Head office, Barrow-in-Furness; Works, Backbarrow, nr. Ulverston.) | C | "VALLEY" .. .. .. | R | 0·60—0·70 | 2·60—2·70 | 3·20—3·40 | 0·85—1·00 | 0·05—0·08 | 0·375—0·45 | 0·45—0·55 | — | Used by chilled roll makers. Grey iron throwing a chill from ½ in. to 1 in. |
| | | R | "LEVEN" Grey .. .. | A | 0·85 | 2·50 | 3·35 | 1·00 | 0·100 | 0·04 | 0·22 | — | Extensively used by malleable iron founders. |
| | | R | ,, V.S.M. .. .. | A | 1·35 | 2·00 | 3·35 | 0·85 | 0·115 | 0·04 | 0·22 | — | |
| | | R | ,, S.M. .. .. .. | A | 1·80 | 1·50 | 3·30 | 0·75 | 0·130 | 0·04 | 0·22 | — | |
| | | R | ,, H.S.M. .. .. | A | 2·05 | 1·25 | 3·30 | 0·65 | 0·145 | 0·04 | 0·22 | — | |
| | | R | ,, H.M. .. .. | A | 2·25 | 1·00 | 3·25 | 0·60 | 0·160 | 0·04 | 0·22 | — | |
| | | R | ,, H.H.M. .. .. | A | 2·45 | 0·80 | 3·25 | 0·55 | 0·165 | 0·04 | 0·22 | — | |
| | | R | ,, S.W. .. .. .. | A | 2·60 | 0·60 | 3·20 | 0·50 | 0·170 | 0·04 | 0·22 | — | |
| | | R | ,, S.P.W. .. .. | A | 2·70 | 0·50 | 3·20 | 0·42 | 0·180 | 0·04 | 0·22 | — | |
| | | R | ,, White .. .. | A | 2·80 | 0·40 | 3·20 | 0·38 | 0·190 | 0·04 | 0·22 | — | |
| 32 | BARROW HEMATITE STEEL CO., LTD., BARROW-IN-FURNESS | H | SPECIAL WEST COAST HOT BLAST .. .. .. .. | A | 0·5 | 3·5 | 4·0 | 2·0 | 0·02 | 0·02 | 0·12 | Arsenic 0·015 | "We cannot guarantee the carbons in any of our irons, but can select iron with 3·90% T.C. when necessary." |
| | | | | R | 0·5—0·5 | 3·25—3·75 | 3·75—4·25 | 1·25—3·00 | 0·01—0·02 | 0·018—0·02 | 0·12 | ,, 0·015 | |
| | | H | SPECIAL INGOT MOULD IRON HOT BLAST .. .. | A | 0·5—0·7 | 3·45 | 4·15 | 2·25 | 0·03 | 0·03 | 0·90 | ,, 0·015 | |
| | | | | R | 0·5 | 3·30—3·6 | 4·0—4·3 | 2·0—2·5 | 0·03 | 0·03 | 0·90 | ,, 0·015 | |
| | | C | MALLEABLE IRON COLD BLAST .. .. .. .. | A | Varying with fracture | | | | 0·12 | 0·04 | 0·22 | ,, 0·015 | |
| | | | | R | 3·25—3·0 | 0·05—0·50 | 3·30—3·50 | 0·5—1·00 | | | | | |
| 33 | WIGAN COAL & IRON CO., WIGAN. | | No reply. | | | | | | | | | | |
| 34 | NORTH LONSDALE IRON & STEEL CO., ULVERSTON. | H | "ULVERSTON BEST SPECIAL." | R | 0·5—0·6 | 3·2—3·6 | (3·7—4·2) | As required from about 2·0 per cent. | 0·02 max. | 0·02 max. | 0·2—1·0 | As, Cu, Cr, etc., only a minute trace in any grade | — |
| | | H | "ULVERSTON SECOND SPECIAL" | R | 0·5—0·6 | 3·2—3·6 | (3·7—4·2) | | 0·025 ,, | 0·025 ,, | 0·2—1·0 | | |
| | | H | "ULVERSTON THIRD SPECIAL" | R | 0·5—0·6 | 3·2—3·6 | (3·7—4·2) | | 0·03 ,, | 0·03 ,, | 0·2—1·0 | | |
| | | H | "ULVERSTON ORDINARY" MALLEABLE, in Medium and Small Pigs— | R | 0·5—0·6 | 3·2—3·6 | (3·7—4·2) | | 0·035 ,, | 0·04 ,, | 0·5—1·0 | | |
| | | C | Grey .. .. .. .. | A | 1·0 | 2·5 | (3·5) | 1·5 | 0·10 | 0·04—0·06 | 0·3 | — | — |
| | | C | Mottled 1 .. .. .. | A | 1·3 | 1·8 | (3·1) | 0·9 | 0·12 | 0·04—0·06 | 0·25 | — | — |
| | | C | ,, 2 .. .. .. | A | 1·6 | 1·5 | (3·1) | 0·8 | 0·13 | 0·04—0·06 | 0·25 | — | — |
| | | C | ,, 3 .. .. .. | A | 1·9 | 1·2 | (3·1) | 0·7 | 0·15 | 0·04—0·06 | 0·25 | — | — |
| | | C | White .. .. .. .. | A | 2·5 | 0·2 | (2·7) | 0·6 | 0·20 | 0·04—0·06 | 0·20 | — | — |

## District "E"—Lancashire—*continued.*

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | Mottled 1 | A | 1·3 | 1·8 | (3·1) | 0·9 | 0·12 | 0·04—0·06 | 0·25 | — | | | | |
| C | ,, 2 | A | 1·6 | 1·5 | (3·1) | 0·8 | 0·13 | 0·04—0·06 | 0·25 | — | | | | |
| C | ,, 3 | A | 1·9 | 1·2 | (3·1) | 0·7 | 0·15 | 0·04—0·06 | 0·25 | — | | | | |
| C | White | A | 2·5 | 0·2 | (2·7) | 0·6 | 0·20 | 0·04—0·06 | 0·20 | — | | | | |

## District "E"—Lancashire—*continued.*

| Index No. | Firm or Works. | Type. | Designation, Grade or Brand. | | COMPOSITION. C. Combd. | C. Gr. | C. Total. | Si. | S. | P. | Mn. | Other Constituents. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | PARTINGTON IRON CO., LTD., IRLAM. | H | SPECIAL BASIC High Manganese | A | 1·0 | 2·0 | 3·0 | 1·3 | 0·07 | 1·45 | 2·00 | — | — |
| | | | | R | 0·5—2·5 | 0·5—2·5 | 2·8—3·1 | 0·9—1·5 | 0·05—0·09 | 1·25—1·65 | 1·7—2·2 | Copper 0·10 Arsenic 0·02 | — |
| | | H | PARTINGTON Foundry Pig | A | — | — | — | 2·30 | 0·06 | 1·00 | 0·75 | — | — |
| | | H | ,, ,, ,, | R | — | — | 3·0 | 1·75—3·25 | 0·04—0·08 | 0·06—1·20 | 0·70—1·00 | — | — |
| 36 | MILLOM & ASKAM CO., LTD., ASKAM. | — | No reply. | | | | | | | | | | |
| 37 | CARNFORTH HEMATITE IRON CO., LTD., CARNFORTH. | — | No reply. | | | | | | | | | | |

## District "F"—South and West Yorkshire.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38 | WALTER SCOTT, LTD., LEEDS. | H | FOUNDRY No. 3 | A | 0·4 | 3·1 | (3·5) | (*a*) 1·86 | 0·032 | 1·02 | 1·75 | Fe by diff. 91·838 | — |
| | | | ,, ,, | R | 0·09—0·6 | 2·40—3·45 | — | 1·5—2·0 | 0·015—0·050 | 0·9—1·2 | 1·4—1·9 | — | — |
| | | | ,, ,, | A | Alternative Silicons | Alternative Silicons | Alternative Silicons | (*b*) 2·33 | — | — | — | 91·368 | — |
| | | | ,, ,, | R | ,, | ,, | ,, | 2·0—2·5 | — | — | — | — | — |
| | | | ,, ,, | A | ,, | ,, | ,, | (*c*) 3·02 | — | — | — | 90·678 | — |
| | | | ,, ,, | R | ,, | ,, | ,, | 2·5—3·5 | — | — | — | — | — |
| | | | ,, ,, | A | ,, | ,, | ,, | (*d*) 4·05 | — | — | — | 89·648 | — |
| | | | ,, ,, | R | ,, | ,, | ,, | 3·5—4·5 | — | — | — | — | — |
| | | H | FOUNDRY No. 4 | A | 0·6 | 2·75 | (3·35) | (*a*) 1·77 | 0·045 | 1·02 | 1·60 | 92·215 | — |
| | | | ,, ,, | R | 0·37—0·7 | 2·35—3·15 | — | 1·50—2·0 | 0·032—0·06 | 0·9—1·20 | 1·3—1·7 | — | — |
| | | | ,, ,, | A | Alternative Silicons | Alternative Silicons | Alternative Silicons | (*b*) 2·24 | — | — | — | 91·745 | — |
| | | | ,, ,, | R | ,, | ,, | ,, | 2·0—2·50 | — | — | — | — | — |
| | | | ,, ,, | A | ,, | ,, | ,, | (*c*) 2·96 | — | — | — | 91·025 | — |
| | | | ,, ,, | R | ,, | ,, | ,, | 2·5—3·5 | — | — | — | — | — |
| | | H | FORGE | A | 0·7 | 2·30 | (3·00) | (*a*) 1·77 | 0·065 | 1·02 | 1·40 | 92·745 | — |
| | | | ,, ,, | R | 0·38—0·8 | 2·15—3·0 | — | 1·5—2·0 | 0·04—0·08 | 0·9—1·2 | 1·2—1·5 | — | — |
| | | | ,, ,, | A | Alternative Silicons | Alternative Silicons | Alternative Silicons | (*b*) 2·24 | — | — | — | 92·275 | — |
| | | | ,, ,, | R | ,, | ,, | ,, | 2·0—2·5 | — | — | — | — | — |
| | | | ,, ,, | A | ,, | ,, | ,, | (*c*) 2·96 | — | — | — | 91·555 | — |
| | | | ,, ,, | R | ,, | ,, | ,, | 2·5—3·5 | — | — | — | — | — |
| | | H | BASIC | A | 1·1 | 1·70 | (2·80) | 0·76 | 0·065 | 1·41 | 1·58 | 93·385 | Basic fracture ranges between white mottled and forge. |
| | | | ,, ,, | R | 0·8—1·26 | 1·4—2·0 | — | 0·5—1·2 | 0·04—0·08 | 1·2—1·7 | 1·4—1·7 | — | |
| 39 | The LOWMOOR IRON CO., LTD., Works at LOWMOOR, nr. BRADFORD. | C | "LOWMOOR" No. 3 | R | — | — | 3·5 | 1·5—1·6 | 0·07—0·10 | 0·35—0·5 | 0·4—0·8 | — | Specially suitable for castings which have to be subjected to heat. |
| | | C | ,, No. 4 | R | — | — | 3·2—3·5 | 1·2—1·4 | 0·07—0·10 | 0·35—0·5 | 0·4—0·8 | — | Less distortion (because less growth). |
| | | C | ,, No. 5 | R | — | — | 3·2—3·5 | 0·8—1·1 | 0·08—0·12 | 0·35—0·5 | 0·4—0·8 | — | |
| | | C | ,, No. 5 hard | R | — | — | 3·2—3·3 | 0·6—0·7 | 0·07—0·1 | 0·35—0·5 | 0·4—0·7 | — | Used in the manufacture of chilled and grain rolls, chemical stills, pans, ducts for hot gases, firebars, etc. |
| | | C | ,, Mottled and white | R | — | — | 2·8 | 0·4—0·5 | 0·14—0·16 | 0·3—0·45 | 0·4—0·6 | — | |
| 40 | PARK GATE IRON & STEEL CO., ROTHERHAM. | H | P.G. LINCOLN No. 3 | A | 0·90 | 2·40 | 3·30 | 2·25 | 0·035 | 1·60 | 1·50 | — | Grades made occasionally during steelworks holidays and repair stoppages. |
| | | H | ,, ,, ,, 3 | R | — | — | — | 2·0—2·5 | 0·02·0·08 | 1·40—1·80 | 1·10—1·70 | — | |
| | | H | ,, ,, No. 4 | A | 1·40 | 2·00 | 3·40 | 1·75 | 0·035 | 1·70 | 1·50 | — | |
| | | H | ,, ,, ,, 4 | R | — | — | — | 1·5—2·0 | 0·02—0·09 | 1·50—1·90 | 1·10—1·70 | — | |
| | | H | ,, ,, Basic | A | 2·40 | 0·90 | 3·30 | 0·90 | 0·05 | 1·90 | 1·60 | — | Practically all the Park Gate output of pig is of the composition as given for Basic. |
| | | H | ,, ,, ,, | R | — | — | — | 0·6—1·20 | 0·03—0·10 | 1·60—2·20 | 1·10—1·80 | — | |

## Trade Talk.

MESSRS. SCOTT'S SHIPBUILDING & ENGINEERING COMPANY, LIMITED, Greenock, have received an order for an oil tanker of 14,000 tons for the Standard Oil Company, of New York.

MESSRS. PRINCEPS & COMPANY, engineers, announce that their address is now St. Peter's Chambers, 14, Campo Lane, Sheffield, and that their business has been reconstructed and put on a sound financial basis.

THE AUDIT of the employers' books for the three months ended June 30 shows the average net selling price of Scotch pig-iron to be £3 17s. 3d. This will result in a reduction in the wages of the workmen of 1 per cent. on basis rates.

AN ACCIDENT OCCURRED at the Lanarkshire steelworks, Motherwell, during the holiday repairs, when the roof of a re-heating furnace collapsed and buried four workmen. They were removed to the infirmary, one being detained with a fractured leg and head injuries.

MESSRS. ALEXANDER STEPHEN & SONS, LIMITED, of Linthouse, Glasgow, are to build two steamers for the P. & O. Company's Straits-China-Japan service. These will be driven by single-reduction geared turbines, with steam from high-pressure water-tube boilers.

MESSRS. MELDRUMS, LIMITED, Timperley, Manchester, report an increasing demand for their mechanical stokers. Orders for 20 stokers recently received were distributed among twelve trades, including steelworks, electrical engineers, railway companies and machine-tool works.

SIR SEFTON BRANCKER visited Falkirk on July 24 in connection with a proposal to establish an aerodrome in the district. During his visit to the Falkirk Ironworks Sir Sefton expressed the opinion that it would be simple to adapt the works for the manufacture of light aircraft parts and aeroplane engines, and also indicated that the port of Grangemouth would make an ideal seaplane base.

THE NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED, of Springburn, Glasgow, have received an order from the Bengal-Nagpur Railways for the supply of 14 pairs of locomotive duplicate cylinders. Instead of the ordinary slide or piston valves, the cylinders are to be adapted to suit Lentz valves. The firm has also secured an order for two locomotive boilers for Buenos Aires Pacific Railway, and have contracted to build six locomotives for the Central Africa Railway.

THE NORTH METROPOLITAN POWER SUPPLY COMPANY, LIMITED, have placed the order for the new extensions to their Brimsdown power station with International Combustion, Limited, of Africa House, Kingsway, London, W.C.2. The new plant will comprise four combustion steam generators of 175,000 to 200,000 lbs. per hour evaporation at 325-lbs. pressure and 780 deg. Fah. final temperature, each boiler being unit fired by Raymond-Lopulco mills.

MR. R. DENNISON, assistant general secretary of the Iron and Steel Trades Confederation, in an interview, commented on the visit of investigation recently paid to Continental steelworks, the report of which has been published by the Government. He said that, without committing his organisation in any way, he considered that one thing to be examined in the light of the report was the means of resisting Continental competition due to low standards of wages and general conditions of employment. It might be necessary, he thought, to go into the question of passing legislation prohibiting the importation into this country of iron and steel from a country where it was known that it was produced under wages and conditions of employment inferior to those recognised as fair in this country.

A PRIVATE CONFERENCE of the North-East Coast district of the Iron and Steel Trades Confederation at Newcastle recently considered the effect of rationalisation and the displacement of workpeople. The conference accepted the process of rationalisation as inevitable, but the general feeling expressed was that in giving assent to it no consideration was being paid to the human factor. The view of the delegates was that alternative employment must be found for those who had served their employers for many years, or that compensation for loss of employment should be agreed to. It was generally accepted that there would be considerable displacement of labour throughout the country due to rationalisation, and the National Executive is to be called upon to examine the problem with a view to framing constructive proposals.

## Contracts Open.

**Cairo,** September 24.—Four electric compressor sets, for the Ministry of Public Works, Egyptian Government. The Department of Overseas Trade. (Reference A.X 9,886.)

**Dessouk, Egypt,** September 30.—Supply and installation of electric motors, pumps, etc., at the Dessouk waterworks, for the Egyptian Ministry of the Interior. The Department of Overseas Trade. (Reference A.X. 9,935.)

**Johannesburg,** September 2.—Transformer, pipeline and transmission line, suspension bridge and telpher gear in connection with extensions to the electricity undertaking, for the Municipality of Umtata. The Department of Overseas Trade. (Reference A.X. 9,874.)

**Newport, Salop,** August 5.—One mile of cast-iron water mains, 8 in. to 3 in. dia., for the Urban District Council. Mr. A. H S. Waters, 25, Temple Row, Birmingham. (Fee £3 3s., returnable.)

**Wealdstone,** August 8. — Scrap-metal bushelling press, for the Urban District Council. Mr. H. Walker, surveyor, Council Offices, Wealdstone.

## Personal.

MR. ALEXANDER ANDERSON, general manager of the North British Locomotive Company, Limited, of Springburn, Glasgow, has just retired.

MR. J. MYLES has been appointed general manager of Messrs. Darwins, Limited, Sheffield, in succession to Mr. P. R. Kuehnrich, whose services are retained as director and consultant.

A PRESENTATION HAS BEEN MADE to Mr. Reginald Ernest Fuller, by the employees of Messrs. R. Fuller & Son, brassfounders, of Church Street, Luton, of which firm he is a partner, on the occasion of his marriage.

MR. JOHN HENRY, foreman patternmaker of the Camelon Iron Company, Limited, Falkirk, has been presented with gifts from the staff and employers to mark the occasion of his retirement after fifty years' service with the firm.

MR. H. J. SHEPPARD has been appointed managing director of Messrs. Johnson & Phillips, Limited, in succession to the late Mr. John MacGregor. Mr. Sheppard has been associated with the company for 39 years and has been a director since 1912.

MR. WALTER JONES, works manager of the Coalbrookdale Company, Limited, structural engineers and ironfounders, of Coalbrookdale, is retiring after nearly 60 years' service with the company. Mr. Jones was he recipient of a presentation recently to mark the occasion.

DR. D. H. INGALL, principal of the Constantine Technical College, Middlesbrough, has been appointed, subject to confirmation, principal of the Northern Polytechnic, Holloway, London. Dr. Ingall has been principal of the Constantine College for the past two years, and the committee of the College gave him nearly £50,000 to equip and organise the new institution on the most modern lines. Members of the Institute of British Foundrymen who visited the College during the recent Middlesbrough Convention will agree that Dr. Ingall has performed this task with amazing efficiency. He was educated at the King Edward High School, Birmingham, and at the Birmingham University, and, after acting as metallurgist to a private company, was appointed senior lecturer in metallurgy at the University of Birmingham. In 1921 he went to the Staffordshire County Technical College, Wednesbury, as head of the metallurgical department. Dr. Ingall is a member of the Institute of British Foundrymen, and at the recent Middlesbrough Convention presented a Paper on "The Factor of Personnel with regard to the Future of British Foundry Practice."

### Wills.

| | |
|---|---|
| PARTRIDGE, E., managing director of Steel Nut & Joseph Hampton, Limited, Woden Works, Wednesbury ... ... | £13,208 |
| LAIDLAW, COLONEL D., engineer and ironfounder, a director of Messrs. R. Laidlaw & Son (Edinburgh), Limited | £16,634 |
| GRAY, J. C., chairman of Messrs. Kirkpatrick, Limited, malleable ironfounders, Walsall ... ... ... | £34,425 |
| COAN, R. J. W., of Clacton-on-Sea, aluminium founder, managing director of Messrs. R. W. Coan, Limited ... | £64,345 |
| CRAWSHAW, M., of Farsley, Yorkshire, formerly of Messrs. John Butler & Company, Limited, Stanningley Ironworks ... ... ... ... ... | £7,601 |

## Obituary.

MR. DOUGLAS URQUHART, general manager of Messrs. Menzies & Company, Limited, shipbuilders and engineers, of Leith, has died at his home in Edinburgh, in his 59th year. He was a native of Sunderland.

SIR EDWARD GRAHAM WOOD, chairman and managing director of Messrs. Edward Wood & Company, Limited, constructional engineers, Manchester, died at his home at Hampstead on Wednesday, July 23, aged 75.

MR. JOHN MACGREGOR, chairman and managing director of Messrs. Johnson & Phillips, Limited, electrical engineers and cable makers, died on Sunday, July 20. He had been connected with the business for over 51 years, and had been managing director since the formation of the present company in 1905.

## Reports and Dividends.

**Palmers Shipbuilding & Iron Company, Limited.**—Trading profit, £25,086; net profit, £6,596; brought in, £12,234; carried forward, £18,830.

**Wellman Smith Owen Engineering Corporation, Limited.**—Net profit, £3,614, reducing the debit balance on profit and loss account to £11,195.

**Darlington Railway Plant & Foundry Company, Limited.**—Profit, £3,548; written off goodwill, £2,500; dividend on 6 per cent. preference shares, £604; carried forward, £6,910.

**Wm. Roberts (Tipton), Limited.**—Profit, £1,694; brought in, £2,654; one year's dividend on the cumulative preference shares to March 31, 1928, absorbing £1,627; carried forward, £2,721.

**Darwins, Limited.**—Trading profit, including profits of subsidiaries, £66,254; net trading profit, £34,746; final dividend of 7½ per cent. on the "A" preference shares; carried forward, £7,007.

**S. P. Austin & Son, Limited.**—Trading profit, £5,605; brought in, £101; income from investments, £5,943; depreciation, debenture interest, etc., £5,123; preference dividend, £3,500; dividend of 2½ per cent. on the ordinary shares, £1,625; carried forward, £751.

**Zinc Corporation, Limited.**—Net profit, £246,050; brought in, £45,022; dividend of 20 per cent. on the preference shares, £49,138; ordinary dividend of 35 per cent.; additional participating dividend on the preference shares of 15 per cent.; general reserve, £21,655; mine development and new plant, £24,509; carried forward, £38,474.

## Patent Specifications Accepted.

*The following list of Patent Specifications accepted has been taken from the "Illustrated Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The last numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.*

37,712. E. M. S. INDUSTRIAL PROCESSES, LIMITED, STOKES, R. A., and ROBERTS, E. G. L. Apparatus for the heat-treatment of metalliferous materials. 330,930.

22,877. BREWER, G. (Krupp Akt.-Ges., F.). Process for manufacturing tools of homogeneous alloys of great hardness. 331,121.

24,643. PALMAER, K. W. Method of removing one or more of the metals of the iron group from solutions containing salts of one or more of the said metals. 318,149.

18,510 LARKIN, J. A. Structural steel framework for building construction. 331,085.

20,667. VOURET, C. Uniting tubular and solid bars or like pieces of metal. 331,107.

27,860. ASSEEV, C. D'. Simultaneously preparing aluminium oxide and pure carbonic acid. 318,976.

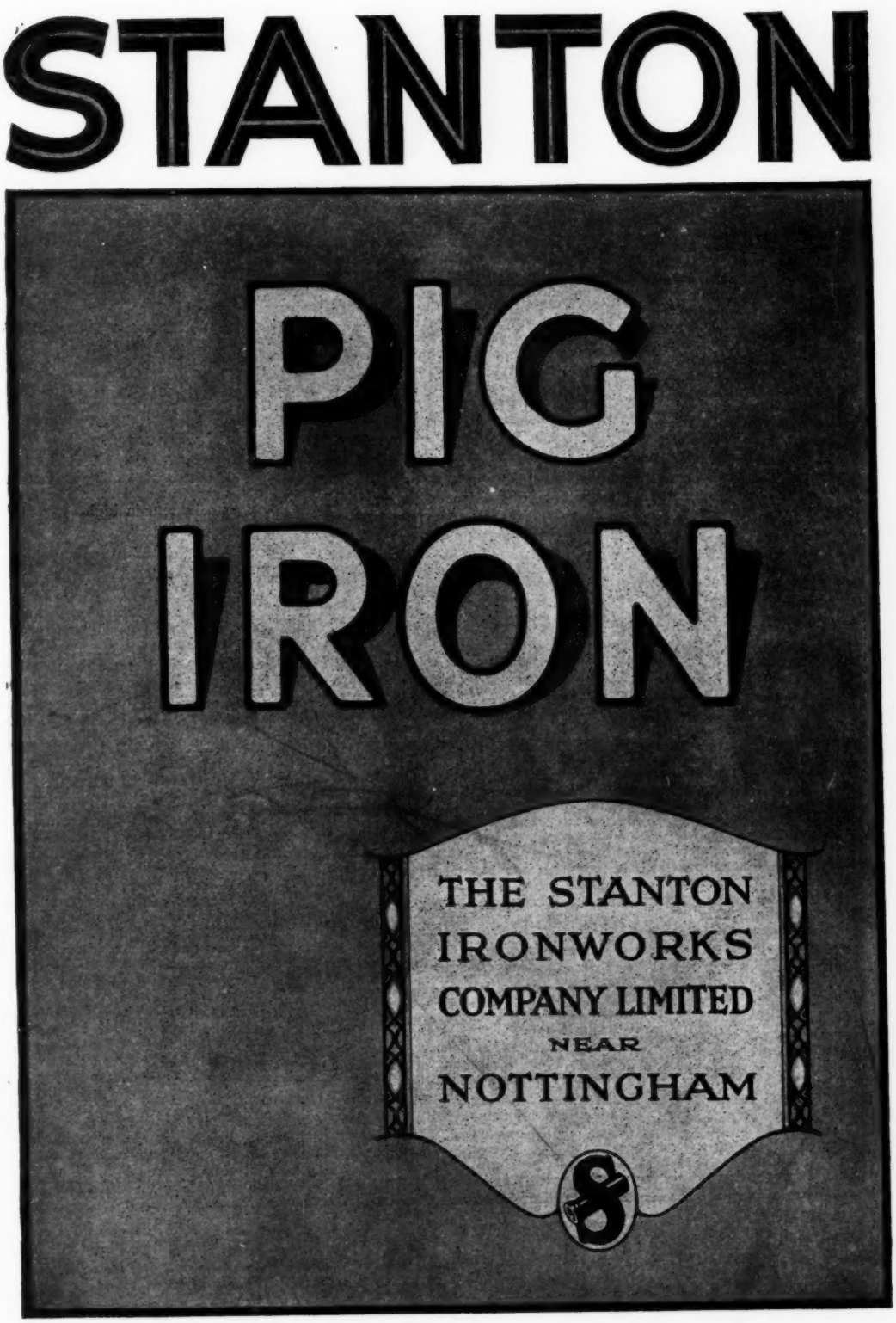
36,065. JUNKERS, H. Apparatus for upsetting sheet metal. 331,175.

9,378. NEUMARK, DR. M. Production of pig-iron. 331,190.

9,584. UNITED STATES METALS REFINING COMPANY. Apparatus for casting metals. 308,689.

10,915. ARDELT, R. Core making for cast pipes. 331,288.

15,322. WEIR, E. Method of producing malleable metal pipes. 317,720.


STANTON
PIG
IRON
THE STANTON
IRONWORKS
COMPANY LIMITED
NEAR
NOTTINGHAM

# Iron and Steel Markets.

## Pig-Iron.

**MIDDLESBROUGH.**—Although traditionally a slack period in the pig-iron industry, it is questionable whether the oldest member of the Tees-side iron market can recall a corresponding instance of such long-continued depression as is now experienced in this normally busy centre of production. The seasonal apathy, which usually extends over the holiday months of July and August, has on this occasion been accentuated by the disturbed condition of markets abroad and by an industrial depression at home which, week by week, grows more pronounced. Few, if any, anticipated that the slump would be so serious, and it is generally recognised that this is not the moment to take business risks. At the same time, trade is now so bad that it can scarcely show further deterioration, and manufacturers and traders incline to the view that by the end of August the worst should be over. A further ominous symptom of the seriousness of the position is furnished in the fact that the foreign invasion has already recommenced. Merchants here have sold fair quantities of Continental iron for delivery on Tees-side, and although local works find Indian pig-iron unsuitable, this latter is still coming into Scotland at very low figures. Notwithstanding the difficulties thus briefly outlined, the Cleveland ironmasters maintain prices, and are able to do so because they have very little for sale. No. 1 Cleveland foundry iron is 70s. per ton, No. 3 G.M.B. 67s. 6d., No. 4 foundry 66s. 6d., and No. 4 forge 66s. per ton.

The recent curtailment of output of East-Coast hematite has to a certain extent had a steadying effect upon markets, although prices are still largely a matter of bargaining, and competition for orders is keenly maintained. The current quotation for mixed numbers so far remains at 71s., with an extra 6d. per ton for No. 1 quality. On the North-West Coast, Bessemer mixed numbers are lower at 70s. per ton at works.

**LANCASHIRE.**—Consumers of foundry pig in this area have only been slightly affected by the recent cut in Midland furnace prices, and business continues confined to almost retail proportions. Local foundries are also, it is reported, being invited to consider offers of Continental iron at tempting cut prices, but so far the movement does not appear to have gained much support. No further change has been made in quotations, which still rule as follow: Derbyshire No. 3, 74s. 6d.; Staffordshire No. 3, 74s. 6d.; and Scottish brands, from 93s. to 94s., all per ton delivered local stations.

**THE MIDLANDS.**—Only a poor demand for foundry pig can be reported in the Black Country area, consumers at the moment mostly holding off the market. There is, however, no difficulty about getting supplies, as production at the present time exceeds the demand, especially in the case of the Northampton furnaces, where good stocks are held. Official prices are 72s. 6d. for Northants No. 3 and 76s. for Derbyshire and Staffordshire No. 3, with Scottish brands 93s. 6d. to 97s. 6d., delivered to local stations.

**SCOTLAND.**—There has been practically no change in the situation since last reported, except that Continental iron has been a shade easier, with the result that one or two lots have been bought, although the total tonnage involved is small. Prices remain unaltered for No. 3 Scotch foundry iron, while Continental foundry iron could probably be obtained at 61s. to 61s. 3d. f.o.t. Grangemouth.

## Finished Iron.

At Birmingham this week, prices of the various grades of bar iron are without change, but, unfortunately, the demand does not suggest any improvement. Both consumers and stockholders are ordering very little at the present time, and very keen competition continues for the small amount of business emanating from the Midlands. The price of crown bars varies from £10 to £10 5s., and nut and bolt iron from £9 to £9 5s. Staffordshire marked bars are at £12 10s. at works, and it is only in connection with this grade that business remains in any way satisfactory.

## Steel.

At Sheffield, nothing of interest has occurred in the steel market, which is altogether featureless. The demand for both acid and basic steel billets is slow, as is that for wire rods. Prices are unchanged. Although the production of open-hearth steel has fallen to an extent which keeps only 30 furnaces operating out of about 80 in this district, the output of special and high-quality steels is on a big scale, with heavy sales both on home and export account. The Continental steelworks announce that a pool for handling British business in semis will be set up this week, which will allocate the orders received amongst the various works. The demand for finished-steel material has been quiet. Irregularity in working continues to characterise this department of the industry, and neither the British nor the Continental works are well placed for orders. In the tinplate market the price remains firm at 18s. basis for coke quality, net cash, f.o.b. Welsh ports.

## Scrap.

In the present stagnant condition of trade generally, it is not surprising that business in foundry scrap material is also adversely affected, and in most markets remain practically at a standstill. On Tees-side, however, there are limited industrial needs to be met, and a few small sales to be registered at prices which do not reflect any further fall in values. Good foundry iron is still a marketable commodity, and sellers have been able to realise 55s. per ton for ordinary quality, whilst foundries requiring machinery quality in handy sizes have paid up to 57s. 6d. In Scotland, holiday influences still predominate, and markets are idle, without much change in prices, which may be repeated at last week's figures, as follow:—Heavy machinery, 63s.; ordinary heavy cast iron, 58s.; steelworks cast iron, 56s. 6d.; railway chairs, 61s. to 62s.; and light metal, 48s. The above prices are all per ton delivered f.o.t. consumers' works.

## Metals.

**Copper.**—Although closing a shade firmer on balance, last week's markets for warrant copper indicated little actual recovery in values, and the tone continues weak and uncertain. New York advices suggest a further drop in electrolytic prices, while there has been no change in the attitude of consumers, and demand for actual consumption remains unimproved. The future of the metal is uncertain.

Closing quotations :—

*Cash.*—Thursday, £48 15s. to £49; Friday, £49 12s. 6d. to £49 15s.; Monday, £48 13s. 9d. to £48 15s.; Tuesday, £48 10s. to £48 12s. 6d.; Wednesday, £48 7s. 6d. to £48 10s.

*Three Months.* — Thursday, £48 10s. to £48 12s. 6d.; Friday, £49 11s. 3d. to £49 12s. 6d.; Monday, £48 10s. to £48 11s. 3d.; Tuesday, £48 7s. 6d. to £48 10s.; Wednesday, £48 3s. 9d. to £48 5s.

**Tin.**—Movements in markets for standard tin during the past week have unquestionably been governed to a large extent by the varying reports of the success of the Tin Producers' Association in their efforts to curtail production. So far as can be ascertained, sentiment on the whole is a little more hopeful. The reported decisions of some Federated Malay States producers to stop operations over a two-months' period have been followed by the announcement of the Association that to date assents have been received in respect of 94 companies operating in British territory and in Siam to restriction proposals.

Official closing prices :—

*Cash.*—Thursday, £134 10s. to £134 15s.; Friday, £134 17s. 6d. to £135; Monday, £135 17s. 6d. to £136; Tuesday, £134 15s. to £135; Wednesday, £134 7s. 6d. to £134 10s.

*Three Months.*—Thursday, £136 2s. 6d. to £136 5s.; Friday, £136 12s. 6d. to £136 15s.; Monday, £137 12s. 6d. to £137 15s.; Tuesday, £136 7s. 6d. to £136 10s.; Wednesday, £135 17s. 6d. to £136.

**Spelter.**—Interest in the spelter market last week was mostly concentrated on the conference in Ostend with the object of forming a new international cartel. The results of the conference were satisfactory so far as the co-operation of producers is concerned, but this did not react on prices, which, as a matter of fact, suffered a decline. Meanwhile **stocks remain high.**

Daily fluctuations :—

*Ordinary.*—Thursday, £16 16s. 3d.; Friday, £16 16s. 3d.; Monday, £16 13s. 9d.; Tuesday, £16 10s.; Wednesday, £16 2s. 6d.

**Lead.**—The market for soft foreign pig continues very quiet, but prices are firmly maintained and unchanged on the week.

The week's prices have been :—

*Soft Foreign (Prompt).*—Thursday, £18 5s.; Friday, £18 5s.; Monday, £18 5s.; Tuesday, £18 6s. 3d.; Wednesday, £18 5s.

## Company Meeting.

**Aluminium Corporation, Limited.**—MR. S. G. BIBBY presided at the annual meeting of the Aluminium Corporation, Limited, and, in moving the adoption of the report and accounts, said that the financial position had been greatly strengthened by the reorganisation that took place in May last. Arrangements had been concluded for improving the works of the company at Dolgarrog, and the requisite new plant and machinery had already been ordered. Owing, however, to the time required for delivery, it was not expected that the work could be completed until late in the autumn. Consequently, the full benefit which the company should ultimately derive as a result of the increased capacity and improvement of the works could not be realised during the present working year. Every effort was being made in the meantime to improve the working conditions at Dolgarrog. Commodity prices had persistently fallen in the world's markets and had now reached an abnormally low level. Competition to secure the limited amount of business offering, therefore, was exceedingly keen.

CAST IRON FLANGED PIPES
2 in.–12 in. & CONNECTIONS. to 24 in. dia.
WE HAVE FIFTY YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.
JAMES & RONALD RITCHIE, LTD.,
Telephone: 52 & 53. MIDDLESBROUGH. Telegrams: "Ritchie, Middlesbrough."

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MANUFACTURERS & PRODUCERS OF REFRACTORY MATERIALS OF EVERY DESCRIPTION
BRICKMAKERS · QUARRY AND MINEOWNERS CONTRACTORS & EXPORTERS.

# GENERAL REFRACTORIES LIMITED

Incorporating
THE GENERAL REFRACTORIES CO., LTD. THE MIDLAND REFRACTORIES CO., LTD.
THOMAS BROOKE & SONS LTD. WORKSOP BRICK CO., LTD. GUISELEY SILICA CO. LTD.

Telegrams: "GENEFRAX" Sheffield London Glasgow Worksop
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KELHAM ISLAND MILLS SHEFFIELD · LOWGROUNDS BRICKWORKS WORKSOP · Notts. · BULLBRIDGE BRICKWORKS AMBERGATE · Derbys · GAYTON ROAD MILLS KINGS LYNN · THE BATTS MILLS WOLSINGHAM · Dur. · BRACKENMOOR FIRECLAY WORKS · STOCKSBRIDGE · LOUDOUN MILLS GALSTON · Ayrshire
AND AT MANSFIELD, WARSOP, EBBERSTON, CORBRIDGE, BRAMCOTE, LUFFENHAM, TOW LAW, MONTGREENAN &c.&c.

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# STEELFOUNDERS

please remember

# WE SELL SAND

BUT

# WE GIVE SERVICE

Our experience and advice on Sand subjects are freely at your disposal. It may be that we can help you if you give us an opportunity.

NOTE:—EXTRA STRONG "YORKSHIRE SAND" is highly concentrated and will carry more floor or mixing sand than any other sand in the world.

# WEEKLY PRICE CURRENT.

## COPPER.

| | £ | s. | d. |
|---|---|---|---|
| Standard cash | 48 | 7 | 6 |
| Three months | 48 | 3 | 9 |
| Electrolytic | 51 | 5 | 0 |
| Tough | 50 | 15 | 0 |
| Best selected | 51 | 5 | 0 |
| Sheets | 79 | 0 | 0 |
| India | 63 | 0 | 0 |
| Wire bars | 52 | 2 | 6 |
| Do. August | 52 | 2 | 6 |
| Do. September | 52 | 2 | 6 |
| Ingot bars | 52 | 2 | 6 |
| H.C. wire rods | 54 | 5 | 0 |
| Off. av. cash, June | 50 | 1 | 4½ |
| Do., 3 mths., June | 50 | 4 | 3⅝ |
| Do., Sttlmnt., June | 50 | 1 | 3 |
| Do., Electro, June | 57 | 11 | 9 |
| Do., B.S., June | 57 | 5 | 7½ |
| Do., wire bars, June | 58 | 8 | 6 |
| Solid drawn tubes | | | 11½d. |
| Brazed tubes | | | 11½d. |
| Wire | | | 8½d. |

## BRASS.

| | |
|---|---|
| Solid drawn tubes | 10½d. |
| Brazed tubes | 12½d. |
| Rods, drawn | 10½d. |
| Rods, extd. or rlld. | 6½d. |
| Sheets to 10 w.g. | 9d. |
| Wire | 8½d. |
| Rolled metal | 8½d. |
| Yellow metal rods | 6½d. |
| Do. 4 × 4 Squares | 7d. |
| Do. 4 × 3 Sheets | 7½d. |

## TIN.

| | £ | s. | d. |
|---|---|---|---|
| Standard cash | 134 | 7 | 6 |
| Three months | 135 | 17 | 6 |
| English | 135 | 0 | 0 |
| Bars | 137 | 0 | 0 |
| Straits | 135 | 10 | 0 |
| Australian | 136 | 5 | 0 |
| Eastern | 138 | 5 | 0 |
| Banca | 138 | 5 | 0 |
| Off. av. cash, June | 136 | 7 | 8¼ |
| Do., 3 mths., June | 138 | 5 | 8½ |
| Do., Sttlmt., June | 136 | 7 | 9 |

## SPELTER.

| | £ | s. | d. |
|---|---|---|---|
| Ordinary | 16 | 2 | 6 |
| Remelted | 14 | 15 | 0 |
| Hard | 13 | 0 | 0 |
| Electro 99.9 | 18 | 15 | 0 |
| English | 16 | 17 | 6 |
| India | 14 | 15 | 0 |
| Zinc dust | 22 | 0 | 0 |
| Zinc ashes | 4 | 0 | 0 |
| Off. aver., June | 16 | 14 | 7½ |
| Aver., spot, June | 16 | 8 | 5½ |

## LEAD.

| | £ | s. | d. |
|---|---|---|---|
| Soft foreign ppt. | 18 | 5 | 0 |
| English | 19 | 15 | 0 |
| Off. average, June | 17 | 19 | 4½ |
| Average spot, June | 17 | 18 | 9½ |

## ZINC SHEETS, &c.

| | £ | s. | d. |
|---|---|---|---|
| Zinc sheets, English | 26 | 0 | 0 |
| Do. V.M. ex-whf. | 25 | 10 | 0 |
| Rods | 30 | 0 | 0 |
| Boiler plates | 22 | 0 | 0 |
| Battery plates | 23 | 0 | 0 |

## ANTIMONY.

| | £ | s. | d. |
|---|---|---|---|
| Special brands, Eng. | 38 | 0 | 0 |
| Chinese | 26 | 0 | 0 |
| Crude | 20 | 0 | 0 |

## QUICKSILVER.

| | £ | s. | d. |
|---|---|---|---|
| Quicksilver | 22 | 10 | 0 |

## FERRO-ALLOYS AND STEEL-MAKING METALS.

| | |
|---|---|
| Ferro-silicon— | |
| 25% | £7 17 6 |
| 45/50% | £11 10 0 |
| 75% | £18 0 0 |
| Ferro-vanadium— | |
| 35/50% | 12/8 lb. Va. |
| Ferro-molybdenum— | |
| 70/75% c. free | 4/2 lb. Mo. |
| Ferro-titanium— | |
| 23/25% carbon-free | 11½d. lb. |
| Ferro-phosphorus, 20/25% | £16 0 0 |
| Ferro-tungsten— | |
| 80/85% | 2/5½ lb. |
| Tungsten metal powder— | |
| 98/99% | 2/8½ lb. |
| Ferro-chrome— | |
| 2/4% car. | £30 10 0 |
| 4/6% car. | £23 10 0 |
| 6/8% car. | £22 7 6 |
| 8/10% car. | £22 0 0 |
| Ferro-chrome— | |
| Max. 2% car. | £33 10 0 |
| Max. 1% car. | £36 17 6 |
| Max. 0.70% car. | £37 17 6 |
| 70% carbon-free | 11d. lb. |
| Nickel—99% cubes, or pellets | £175 0 0 |
| Ferro-cobalt | 9/7 lb. |
| Aluminium 98/99% | £95 0 0 |
| Metallic chromium— | |
| 96/98% | 2/7 lb. |
| Ferro-manganese (net)— | |
| 76/80% loose | £11 0 0 to £11 15 0 |
| 76/80% packed | £12 0 0 to £12 15 0 |
| 76/80% export | £11 0 0 to £11 15 0 |
| Metallic manganese— | |
| 94/96% carbonless | 1/4 lb. |

Per ton unless otherwise stated.

## HIGH-SPEED TOOL STEEL.

| | |
|---|---|
| Finished bars, 14% tungsten | £0 2 2 |
| Finished bars, 18% tungsten | £0 3 0 |

Per lb. net, d/d buyers' works.

Extras—

| | |
|---|---|
| Rounds and squares, 3 in. and over | 4d. lb. |
| Rounds and squares, under ½ in. to ¼ in. | 3d. lb. |
| Do., under ¼ in. to $\frac{7}{16}$ in. | 1/- lb. |
| Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in. | 3d. lb. |
| Do., under ½ in. × ⅛ in. | 1/- lb. |
| Bevels of approved sizes and sections | 6d. lb. |

Bars cut to length, 10% extra.

## SCRAP.

| | £ | s. | d. | £ | s. | d. |
|---|---|---|---|---|---|---|
| South Wales— | | | | | | |
| Heavy steel | | | | 2 | 15 | 0 |
| Bundled steel and shrngs. | 2 | 10 | 0 | to 2 | 13 | 0 |
| Mixed iron and steel | 2 | 7 | 6 | to 2 | 10 | 0 |
| Heavy cast iron | 2 | 14 | 0 | to 2 | 15 | 0 |
| Good machinery for foundries | 2 | 15 | 0 | to 2 | 17 | 6 |
| Cleveland— | | | | | | |
| Heavy steel | | | | 2 | 8 | 0 |
| Steel turnings | | | | 2 | 2 | 6 |
| Cast-iron borings | | | | 1 | 19 | 0 |
| Heavy forge | | | | 3 | 7 | 6 |
| W.I. piling scrap | | | | 3 | 3 | 0 |
| Cast-iron scrap | 2 | 15 | 0 | to 2 | 17 | 6 |
| Midlands— | | | | | | |
| Ord. cast-iron scrap | | | | 2 | 12 | 6 |
| Heavy wrought | | | | 3 | 5 | 0 |
| Steel turnings | | | | 1 | 7 | 0 |
| Scotland— | | | | | | |
| Heavy steel | | | | 2 | 10 | 0 |
| Ordinary cast iron | | | | 2 | 18 | 0 |
| Engineers' turnings | | | | 1 | 18 | 6 |
| Cast-iron borings | | | | 1 | 17 | 6 |
| Wrought-iron piling | | | | 3 | 11 | 6 |
| Heavy machinery | | | | 3 | 3 | 0 |

London—Merchants' buying prices delivered yard.

| | £ | s. | d. |
|---|---|---|---|
| Copper (clean) | 44 | 0 | 0 |
| Brass | 32 | 10 | 0 |
| Lead (less usual draft) | 16 | 5 | 0 |
| Tea lead | 12 | 15 | 0 |
| Zinc | 9 | 10 | 0 |
| New aluminium cuttings | 56 | 0 | 0 |
| Braziery copper | 41 | 0 | 0 |
| Gunmetal | 43 | 0 | 0 |
| Hollow pewter | 100 | 0 | 0 |
| Shaped black pewter | 75 | 0 | 0 |

## PIG-IRON.

*(f.o.t. unless otherwise stated.)*

| | |
|---|---|
| N.E. Coast— | |
| Foundry No. 1 | 70/- |
| Foundry No. 3 | 67/6 |
| Foundry No. 4 | 66/6 |
| Forge No. 4 | 66/- |
| Hematite No. 1 | 71/6 |
| Hematite M/Nos. | 71/- |
| N.W. Coast— | |
| Hem. M/Nos. d/d Glas. | 84/- |
| „ d/d Birm. | 88/6 |
| Midlands— | |
| Staffs. common* | — |
| „ No. 4 forge* | 71/- |
| „ No. 3 fdry.* | 76/- |
| Shrops. basic | — |
| „ Cold blast, ord. | — |
| „ „ roll iron | — |
| Northants forge* | 67/6 |
| „ fdry. No. 3* | 72/6 |
| Derbyshire forge* | 71/- |
| „ fdry. No. 3* | 76/- |
| „ basic* | — |

*d/d Black Country dist.

| | |
|---|---|
| Scotland— | |
| Foundry No. 1 | 79/- |
| „ No. 3 | 76/6 |
| Hem. M/Nos. | 79/6 |
| Sheffield (d/d district)— | |
| Derby forge | 66/- |
| „ fdry. No. 3 | 71/- |
| Lincs. forge | — |
| „ fdry. No. 3 | 72/6 |
| E.C. hematite | 83/6 |
| W.C. hematite | 87/6 |
| Lincs. (at furnaces)— | |
| Forge No. 4 | — |
| Foundry No. 3 | — |
| Basic | — |
| Lancashire (d/d eq. Man.)— | |
| Derby forge | 69/6 |
| „ fdry. No. 3 | 74/6 |
| Staffs foundry No. 3 | 74/6 |
| Dalzell, No. 3 (special) | 105/- to 107/6 |
| Summerlee, No. 3 | 93/- to 94/- |
| Glengarnock, No. 3 | — |
| Gartsherrie, No. 3 | 93/- to 94/- |
| Monkland, No. 3 | 93/- to 94/- |
| Shotts, No. 3 | 93/- to 94/- |

## FINISHED IRON AND STEEL.

*Usual District deliveries for iron; delivered consumers' station for steel.*

| Iron— | £ | s. | d. | £ | s. | d. |
|---|---|---|---|---|---|---|
| Bars (cr.) | 10 | 0 | 0 | to 10 | 15 | 0 |
| Nut and bolt iron | 9 | 0 | 0 | to 9 | 5 | 0 |
| Hoops | | | | 10 | 15 | 0 |
| Marked bars (Staffs) f.o.t. | | | | 12 | 10 | 0 |
| Gas strip | | | | 10 | 15 | 0 |
| Bolts and nuts, ¾ in. × 4 in. | | | | 15 | 5 | 0 |
| Steel— | | | | | | |
| Ship plates | 8 | 15 | 0 | to 8 | 17 | 6 |
| Boiler plts. | 9 | 15 | 0 | to 10 | 10 | 0 |
| Chequer plts. | | | | 10 | 12 | 6 |
| Angles | | | | 8 | 7 | 6 |
| Tees | | | | 9 | 7 | 6 |
| Joists | | | | 8 | 10 | 0 |
| Rounds and squares, 3 in. to 5½ in. | | | | 9 | 7 | 6 |
| Rounds under 3 in. to ¾ in. (Untested) | | | | 7 | 15 | 0 |

and upwards

| | £ | s. | d. |
|---|---|---|---|
| Flats—8 in. wide and over | 8 | 12 | 6 |
| „ under 8 in. and over 5 in. | 8 | 17 | 6 |
| Rails, heavy | 8 | 10 | 0 |
| Fishplates | 12 | 0 | 0 |
| Hoops (Staffs) | 9 | 5 | 0 to 9 15 0 |
| Black sheets, 24 g. | 9 | 12 | 6 to 9 15 0 |
| Galv.cor.shts., 24g. | 11 | 17 | 6 |
| Galv. fencing wire, 8g. plain | 12 | 0 | 0 |
| Billets, soft | 5 | 17 | 6 to 6 5 0 |
| Billets, hard | 7 | 10 | 0 to 8 0 0 |
| Sheet bars | 5 | 12 | 6 to 6 0 0 |
| Tin bars | | | 6 0 |

## PHOSPHOR BRONZE.

| | Per lb. basis. |
|---|---|
| Strip | 1/0½ |
| Sheet to 10 w.g. | 1/1½ |
| Wire | 1/1½ |
| Rods | 1/1½ |
| Tubes | 1/5½ |
| Castings | 1/1½ |

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

## NICKEL SILVER, &c.

| | per lb. |
|---|---|
| Ingots for raising | 8d. to 1/2 |
| Rolled— | |
| To 9 in. wide | 1/2 to 1/8 |
| To 12 in. wide | 1/2½ to 1/8½ |
| To 15 in. wide | 1/2½ to 1/8½ |
| To 18 in. wide | 1/3 to 1/9 |
| To 21 in. wide | 1/3½ to 1/9½ |
| To 25 in. wide | 1/4 to 1/10 |
| Ingots for spoons and forks | 8d. to 1/4½ |
| Ingots rolled to spoon size | 11d. to 1/7½ |
| Wire round— | |
| 3/0 to 10 G. | 1/5½ to 2/0½ |

with extras according to gauge.

## AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

| | Dols. |
|---|---|
| No. 2 foundry, Phila. | 19.76 |
| No. 2 foundry, Valley | 18.00 |
| No. 2 foundry, Birm. | 14.00 |
| Basic | 19.76 |
| Bessemer | 20.26 |
| Malleable | 20.26 |
| Grey forge | 19.26 |
| Ferro-mang. 80% | 94.00 |
| O.-h. rails, h'y, at mill | 43.00 |
| Billets | 31.00 |
| Sheet bars | 31.00 |
| Wire rods | 36.00 |
| | Cents. |
| Iron bars, Phila. | 2.09 |
| Steel bars | 1.65 |
| Tank plates | 1.65 |
| Beams, etc. | 1.65 |
| Skelp, grooved steel | 1.70 |
| Skelp, sheared steel | 1.70 |
| Steel hoops | 2.10 |
| Sheets, black, No. 24 | 2.45 |
| Sheets, galv., No. 24 | 3.15 |
| Sheets, blue an'l'd, No. 13 | 2.15 |
| Wire nails | 2.05 |
| Plain wire | 2.30 |
| Barbed wire, galv. | 2.80 |
| Tinplates, 100-lb. box | $5.25 |

## COKE (at ovens).

| | |
|---|---|
| Welsh foundry | 25/- to 27/6 |
| „ furnace | 17/- to 21/- |
| Durham and Northumberland— | |
| „ foundry | 14/6 to 15/6 |
| „ furnace | 14/- to 14/6 |
| Midlands, foundry | — |
| „ furnace | — |

## TINPLATES.

f.o.b. Bristol Channel ports.

| | | |
|---|---|---|
| I.C. cokes | 20×14 box | 18/- |
| „ | 28×20 „ | 36/- |
| „ | 20×10 „ | 26/- |
| „ | 18½×14 „ | 18/9 |
| C.W. | 20×14 „ | 16/6 |
| „ | 28×20 „ | 33/6 |
| „ | 20×10 „ | 23/6 |
| „ | 18½×14 „ | 17/- |
| Terneplates | 28×20 | 32/6 per box basis f.o.b. |

## SWEDISH CHARCOAL IRON & STEEL.

| | |
|---|---|
| Pig-iron | £6 0 0 to £7 10 0 |
| Bars, hammered, basis | £17 10 0 to £18 10 0 |
| Bars and nail-rods, rolled, basis | £15 17 6 to £16 15 0 |
| Blooms | £10 0 0 to £12 0 0 |
| Keg steel | £32 0 0 to £33 0 0 |
| Faggot steel | £20 0 0 to £24 0 0 |
| Bars and rods dead soft, steel | £11 0 0 to £14 0 0 |

All per English ton, f.o.b. Gothenburg.

### TUBES AND FITTINGS.

Over ⅛ in. up to 6 in.

| | *Tubes.* | *Fittings.* |
|---|---|---|
| Gas .. .. | 62½% | 47½% |
| Water .. | 58½% | 42½% |
| Steam .. | 55% | 37½% |

W.I. 12½% extra.

### DAILY FLUCTUATIONS.

**Standard Copper** (cash).

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| July | 24 .. | 48 | 15 | 0 | inc. 26/3 |
| ,, | 25 .. | 49 | 12 | 6 | ,, 17/6 |
| ,, | 28 .. | 48 | 13 | 9 | dec. 18/9 |
| ,, | 29 .. | 48 | 10 | 0 | ,, 3/9 |
| ,, | 30 .. | 48 | 7 | 6 | ,, 2/6 |

**Electrolytic Copper.**

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| July | 24 .. | 50 | 10 | 0 | No change |
| ,, | 25 .. | 51 | 10 | 0 | inc. 20/- |
| ,, | 28 .. | 51 | 10 | 0 | No change |
| ,, | 29 .. | 51 | 10 | 0 | ,, ,, |
| ,, | 30 .. | 51 | 5 | 0 | dec. 5/- |

**Standard Tin** (cash).

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| July | 24 .. | 134 | 10 | 0 | No change |
| ,, | 25 .. | 134 | 17 | 6 | inc. 7/6 |
| ,, | 28 .. | 135 | 17 | 6 | ,, 20/- |
| ,, | 29 .. | 134 | 15 | 0 | dec. 22/6 |
| ,, | 30 .. | 134 | 7 | 6 | ,, 7/6 |

**Tin** (English ingots).

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| July | 24 .. | 135 | 10 | 0 | No change |
| ,, | 25 .. | 135 | 15 | 0 | inc. 5/- |
| ,, | 28 .. | 136 | 15 | 0 | ,, 20/- |
| ,, | 29 .. | 135 | 10 | 0 | ,, 25/- |
| ,, | 30 .. | 135 | 0 | 0 | ,, 5/- |

**Zinc Sheets** (English).

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| July | 24 .. | 26 | 0 | 0 | No change |
| ,, | 25 .. | 26 | 0 | 0 | ,, ,, |
| ,, | 28 .. | 26 | 0 | 0 | ,, ,, |
| ,, | 29 .. | 26 | 0 | 0 | ,, ,, |
| ,, | 30 .. | 26 | 0 | 0 | ,, ,, |

**Spelter** (ordinary).

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| July | 24 .. | 16 | 16 | 3 | No change |
| ,, | 25 .. | 16 | 16 | 3 | ,, ,, |
| ,, | 28 .. | 16 | 13 | 9 | dec. 2/6 |
| ,, | 29 .. | 16 | 10 | 0 | ,, 3/9 |
| ,, | 30 .. | 16 | 2 | 6 | ,, 7/6 |

**Lead** (English).

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| July | 24 .. | 19 | 15 | 0 | No change |
| ,, | 25 .. | 19 | 15 | 0 | ,, ,, |
| ,, | 28 .. | 19 | 15 | 0 | ,, ,, |
| ,, | 29 .. | 19 | 15 | 0 | ,, ,, |
| ,, | 30 .. | 19 | 15 | 0 | ,, ,, |

## AVERAGE MONTHLY PRICES OF DERBYSHIRE NO. 3 FOUNDRY AT MANCHESTER.

| Year | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Yearly average. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. |
| 1895 .. .. | 2 3 0 | 2 3 0 | 2 2 6 | 2 2 6 | 2 2 6 | 2 4 0 | 2 3 6 | 2 4 0 | 2 5 0 | 2 5 6 | 2 6 6 | 2 5 6 | 2 3 11½ |
| 1896 .. .. | 2 5 6 | 2 6 0 | 2 6 0 | 2 6 0 | 2 6 0 | 2 5 6 | 2 5 0 | 2 5 0 | 2 5 0 | 2 6 0 | 2 7 0 | 2 8 6 | 2 5 11½ |
| 1897 .. .. | 2 10 0 | 2 11 0 | 2 9 0 | 2 8 6 | 2 8 0 | 2 7 0 | 2 7 0 | 2 7 0 | 2 6 0 | 2 6 0 | 2 6 6 | 2 7 6 | 2 7 9½ |
| 1898 .. .. | 2 7 6 | 2 8 0 | 2 8 0 | 2 8 0 | 2 8 6 | 2 10 0 | 2 10 0 | 2 10 0 | 2 10 0 | 2 11 0 | 2 14 0 | 2 14 0 | 2 9 11 |
| 1899 .. .. | 2 13 0 | 2 14 0 | 2 14 0 | 2 14 0 | 3 0 0 | 3 2 0 | 3 13 0 | 3 16 6 | 3 15 0 | 3 16 6 | 3 16 6 | 4 0 0 | 3 6 2½ |
| 1900 .. .. | 4 0 0 | 4 0 0 | 4 0 0 | 4 1 6 | 4 1 0 | 3 18 0 | 3 13 6 | 3 12 6 | 3 11 0 | 3 11 0 | 3 9 6 | 3 8 0 | 3 15 5 |
| 1901 .. .. | 2 13 6 | 2 17 0 | 2 15 0 | 2 15 0 | 2 14 0 | 2 13 9 | 2 13 6 | 2 13 6 | 2 14 6 | 2 13 0 | 2 12 6 | 2 16 6 | 2 14 3½ |
| 1902 .. .. | 2 17 6 | 2 17 6 | 2 15 6 | 2 16 9 | 2 16 6 | 2 16 6 | 2 16 6 | 2 17 0 | 2 18 6 | 2 18 6 | 2 17 6 | 2 17 6 | 2 17 1½ |
| 1903 .. .. | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 |
| 1904 .. .. | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 | 2 17 6 |
| 1905 .. .. | 2 13 0 | 2 13 0 | 2 11 6 | 2 12 6 | 2 12 0 | 2 12 0 | 2 12 3 | 2 12 3 | 2 14 0 | 2 16 6 | 3 0 0 | 3 0 6 | 2 14 1 |
| 1906 .. .. | 3 2 0 | 3 5 0 | 3 3 0 | 3 0 6 | 2 17 0 | 2 18 6 | 2 18 0 | 2 16 6 | 2 19 0 | 3 0 6 | 3 1 6 | 3 7 0 | 3 0 8½ |
| 1907 .. .. | 3 7 0 | 3 7 0 | 3 5 0 | 3 2 0 | 3 4 0 | 3 8 0 | 3 6 0 | 3 5 0 | 3 4 0 | 3 2 6 | 3 1 0 | 2 18 6 | 3 4 2 |
| 1908 .. .. | 2 15 0 | 2 14 6 | 2 14 6 | 2 15 6 | 2 14 0 | 2 13 0 | 2 13 0 | 2 11 6 | 2 12 6 | 2 13 0 | 2 12 6 | 2 12 6 | 2 13 5½ |
| 1909 .. .. | 2 13 0 | 2 12 6 | 2 11 6 | 2 12 0 | 2 12 6 | 2 12 6 | 2 12 0 | 2 12 6 | 2 14 6 | 2 15 0 | 2 14 6 | 2 14 0 | 2 13 0½ |
| 1910 .. .. | 2 13 9 | 2 14 0 | 2 14 0 | 2 14 4 | 2 15 0 | 2 15 0 | 2 14 9 | 2 15 0 | 2 15 0 | 2 15 0 | 2 15 0 | 2 15 0 | 2 14 7½ |
| 1911 .. .. | 2 16 0 | 2 16 0 | 2 16 0 | 2 16 0 | 2 16 0 | 2 16 0 | 2 16 0 | 2 16 0 | 2 16 0 | 2 14 8 | 2 15 0 | 2 15 0 | 2 15 8½ |
| 1912 .. .. | 2 17 4½ | 2 17 6 | 2 17 6 | 3 1 1½ | 3 2 6 | 3 3 9 | 3 6 3 | 3 7 6 | 3 10 10½ | 3 12 6 | 3 13 3½ | 3 14 6 | 3 5 4 |
| 1913 .. .. | 3 15 7 | 3 15 0 | 3 11 10½ | 3 11 4½ | 3 10 2½ | 3 6 10½ | 3 4 2½ | 3 2 9 | 3 1 9 | 3 1 0 | 2 19 3 | 2 17 2½ | 3 6 5 |
| 1914 .. .. | 2 17 2½ | 2 18 0 | 2 18 0 | 2 17 0 | 2 17 0 | 2 16 7½ | 2 16 0 | 3 2 10 | 3 1 0 | 2 19 9½ | 2 16 11½ | 2 18 1½ | 2 18 2 |
| 1915 .. .. | 3 1 2 | 3 3 11 | 3 5 9 | 3 18 8½ | 3 13 7 | 3 14 1 | 3 15 0 | 3 13 3 | 3 12 0½ | 3 11 1 | 3 14 0 | 4 3 3 | 3 12 2½ |
| 1916 .. .. | 4 4 6½ | 4 11 6 | 4 11 6½ | 4 7 6 | 4 7 6 | 4 7 6 | 4 10 0 | 4 12 10 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 8 6½ |
| 1917 .. .. | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 |
| 1918 .. .. | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 |
| 1919 .. .. | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 7 2 6 | 7 5 0 | 8 8 5 | 9 0 0 | 9 0 0 | 9 0 0 | 9 0 0 | 9 0 0 | 7 3 10 |
| 1920 .. .. | 9 13 9 | 10 0 0 | 10 5 3 | 10 15 3 | 11 10 0 | 12 2 6 | 12 5 0 | 13 1 3 | 14 7 6 | 14 5 0 | 14 5 0 | 14 5 0 | 12 12 1½ |
| 1921 .. .. | 12 11 8 | 10 8 9 | 9 2 6 | 8 2 0 | 8 0 0 | 8 0 0 | 8 0 0 | 8 1 8 | 7 4 0 | 6 7 6 | 5 7 6 | 4 16 10 | 8 0 2 |
| 1922 .. .. | 5 5 0 | 4 17 6 | 4 15 0 | 4 15 0 | 4 12 6 | 4 12 6 | 4 12 6 | 4 12 6 | 4 11 3 | 4 10 0 | 4 10 0 | 4 10 0 | 4 13 7½ |
| 1923 .. .. | 4 12 8½ | 5 0 2 | 6 2 6 | 6 8 7½ | 6 2 5 | 5 11 9 | 5 9 1½ | 5 4 0 | 5 0 0 | 5 0 9 | 5 0 7 | 5 2 9 | 5 7 11½ |
| 1924 .. .. | 5 3 0 | 5 3 0 | 5 3 0 | 5 3 0 | 5 2 10 | 5 1 3 | 4 17 11 | 4 15 6 | 4 13 6 | 4 10 1½ | 4 10 0 | 4 10 3 | 4 17 9½ |
| 1925 .. .. | 4 10 0 | 4 9 0 | 4 6 9 | 4 5 2½ | 4 3 0 | 4 0 1½ | 4 17 1½ | 3 15 7½ | 3 14 3½ | 3 13 4½ | 3 13 4½ | 3 13 2½ | 4 1 9 |
| 1926 .. .. | 3 14 9 | 3 15 3 | 3 15 6 | 3 15 3½ | 3 17 6 | 4 5 9 | 4 16 9 | * | * | * | * | 4 12 6 | 4 0 1½ |
| 1927 .. .. | 4 13 2½ | 4 13 3 | 4 11 1½ | 4 9 4½ | 4 6 1½ | 3 19 1½ | 3 16 1½ | 3 15 6 | 3 13 4½ | 3 13 4½ | 3 14 0 | 3 13 6½ | 4 1 6½ |
| 1928 .. .. | 3 13 2½ | 3 12 3½ | 3 12 3 | 3 12 3 | 3 11 6 | 3 10 0 | 3 8 3 | 3 7 8½ | 3 7 6 | 3 7 9½ | 3 8 3 | 3 7 6 | 3 9 10½ |
| 1929 .. .. | 3 8 3½ | 3 10 4½ | 3 10 10½ | 3 11 0 | 3 11 2½ | 3 12 0 | 3 12 4½ | 3 14 6 | 3 15 1½ | 3 17 0 | 3 17 0 | 3 17 0 | 3 13 1½ |
| 1930 .. .. | 3 17 0 | 3 17 0 | 3 17 0 | 3 17 0 | 3 17 0 | 3 17 0 | 3 15 0 | — | — | — | — | — | — |

* No prices available during strike period.


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|---|---|
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